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SNAKE RIVER BIRDS OF PREY RESEARCH PROJECT

ANNUAL REPORT

1990

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PREFACE

This report summarizes research and monitoring activities in the Snake River Birds of Prey Area (SRBOPA) during calendar year 1990.

Two significant events regarding the research in the Snake River Birds of Prey Area occurred in 1990. The first was establishment of the Raptor Research and Technical Assistance Center (RRTAC) in March 1990. The BLM and Boise State University (BSU) form the 2 branches of RRTAC. The Branch of Applied Research and Governmental Affairs is presently composed of the BLM's Snake River Birds of Prey Research staff; however, a BLM Technical Assistance staff is proposed. The RRTAC Branch of Basic Research and Academic Affairs is comprised by BSU's Raptor Research Center. Other RRTAC members include the University of Idaho, Idaho State University, U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, and The Peregrine Fund. The second event was the initiation of field work for the cooperative BLM/Idaho Army National Guard Research Project. This 5-year project is investigating the effects of military activity and fire on the raptors, their prey, and their habitat in the SRBOPA. Five component studies (Table 1) comprise the research project. Four studies initiated field work in 1990. Work consisted mainly of pilot studies where techniques and approaches were tested. Study plans for specific studies were revised, and an integration workshop was held in September.

Table 1. Component Studies of the BLM/IDARNG Research Project

STUDY 1.	*Raptor Distribution and Use of the Orchard Training Area (OTA) and Adjacent Areas.* Tom J. Cade and Christine Watson, Principal Investigators. Raptor Research and Technical Assistance Center, Boise State University.
STUDY 2.	*Raptor Habitat Use and Foraging Behavior.* James C. Bednarz, Principal Investigator. Greenfalk Consultants.
STUDY 3.	*Raptor Nesting Densities and Reproductive Success.* Michael N. Kochert, Robert N. Lehman, Karen Steenhof, Principal Investigators. Raptor Research and Technical Assistance Center, BLM.
STUDY 4.	*Townsend's Ground Squirrel Abundance, Productivity, and Habitat Relationships.* Beatrice Van Horne, Principal Investigator. Colorado State University.
STUDY 5.	*Vegetation Classification/Description and the Ability of Soils/Vegetation to Support Ground Squirrel and Jackrabbit Populations.* Steven T. Knick, Principal Investigator. Raptor Research and Technical Assistance Center, BLM.
STUDY INTEGRATION	John Rotenberry, Principal Investigator. University of California, Riverside.

Work continued on other cooperative studies in 1990. M.S. theses from Boise State University were completed for Helen Ulmschneider's long-eared owl study and Dawn McAnnis' ferruginous hawk study. Scott Grothe, a graduate student from Idaho State University, initiated a red-tailed hawk predation study in 1990. The cooperative nesting study with Pacific Power and Light Company (PP&L) continued at a reduced level than in past years, and Alison Beck-Haas was again contracted to monitor raven roosting on the PP&L line.

Other 1990 field activities included continuing investigations of common barn-owl feeding ecology by Dr. Carl Marti of Weber State University, assessment of nest box use by American kestrels by Karen Steenhof, and studies of western screech-owl and northern saw-whet owls using nest boxes in the SRBOPA by Jeff Marks and John Doremus.

Monitoring of Townsend's ground squirrel and black-tailed jackrabbits was carried out by Study 5 of the BLM/IDARNG Research Project with the assistance of IDARNG personnel. U.S. Army Corps of Engineers, CERL, again conducted monitoring activities in the Orchard Training Area in cooperation with the IDARNG. Monitoring of winterfat seeding projects by the U.S. Forest Services Laboratory and the Idaho BLM State Office continued, and the Idaho BLM State Office also monitored greenstrips within the SRBOPA.

Although the main thrust for 1990 was implementation of the BLM/IDARNG Research Project and continuation of cooperative research projects, work still continued on Technology Transfer. Four scientific papers were published and/or accepted for publication in 1990, and BLM RRTAC staff and associates made 6 technical presentations at meetings.

ACKNOWLEDGMENTS

The Bureau of Land Management wishes to thank those agencies and individuals who assisted with the project. Appreciation is extended to the Idaho Department of Fish and Game and the U.S. Fish and Wildlife Service for special permits and assistance. Special thanks go to all other individuals who volunteered their services.

COOPERATING AGENCIES AND INSTITUTIONS

Boise State University, Raptor Research Center
College of Idaho
Colorado State University
Greenfalk Consultants
Idaho Army National Guard
Idaho Department of Fish and Game
Idaho Department of Transportation
Idaho Department of Water Resources
Idaho Power Company
Idaho State University
Pacific Power and Light Company
University of Idaho
University of Wisconsin
U.S. Army Corps of Engineers, CERL
USDA Agricultural Research Service
U.S. Fish and Wildlife Service
U.S. Forest Service Intermountain Research Station
Weber State University
World Center for Birds of Prey

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PART I

TECHNOLOGY TRANSFER

Snake River Birds of Prey Area
Technical Articles Published and/or Accepted for Publication

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* Published and/or accepted for publication in 1990. Reprints of most of these articles are available from the Birds of Prey Research Project, Boise District, BLM, 3948 Development Avenue, Boise, ID 83709.

1990 Birds of Prey Research Technical Presentations

03/02/90 Holthuijzen, A.M.A. Prey Procurement time in prairie falcons in relation to prey abundance. Annual Meeting, Idaho Chapter of the Wildlife Society. Boise, Idaho.

03/02/90 Spahr, R., M. Bechard, and K. Steenhof. Factors affecting the distribution of wintering bald eagles in an urban area. Annual Meeting, Idaho Chapter of the Wildlife Society. Boise, Idaho.

03/02/90 Ulmschneider, H. Post-nesting movements of long-eared owls in southwest Idaho, part two. Annual Meeting, Idaho Chapter of the Wildlife Society. Boise, Idaho.

08/01/90 Marti, C.D., K. Steenhof, M.N. Kochert, and J.S. Marks. Trophic relationships and guild structure among vertebrate predators in southwestern Idaho. Annual Meeting, Ecological Society of America. Snow Bird, Utah.

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PART II

PROGRESS REPORTS

Raptor Nesting Densities and Reproductive Success in the Snake River Birds of Prey Area, 1990

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Annual Summary

Golden eagle (Aquila chrysaetos) nesting density in the SRBOPA did not change from 1989 to 1990 but declined slightly from 1987-1988 levels. Number of young fledged per pair increased to its highest level since 1982 and for the first time exceeded that in the Comparison Area. Prairie falcon (Falco mexicanus) density in the SRBOPA was slightly higher than in 1978, when the last complete survey was done, but the number of falcon pairs decreased from 1976-1977 levels. Fixed-point surveys of prairie falcon density were slightly more effective than walking surveys in the number of pairs located per hr of effort. Prairie falcon productivity in 1990 was slightly higher than the mean for 1974-1990. Surveys of 16 4-km² quadrats for ground-nesting raptors north of the canyon suggested that raptor nests occur at low densities on the benchlands. Only 4 breeding pairs of raptors were found in the 16 quadrats.

OBJECTIVES:

1. Assess golden eagle density and productivity in the SRBOPA and Comparison Area.
2. Assess prairie falcon density in the SRBOPA.
3. Assess prairie falcon productivity at preselected sites.
4. Assess the effectiveness of quadrat surveys in determining density of ground-nesting raptors in and near the OTA.
5. Assess the effectiveness of point surveys, conducted from fixed observation points, vs. walking surveys, conducted without fixed points, as a means of monitoring prairie falcon density.

INTRODUCTION

The overall objective of Study 3 is to determine if raptor nesting densities and reproductive success in the SRBOPA have changed over time and if any such changes can be correlated with military use and fire occurrence. In addition, the best long-term approach for monitoring raptor densities and productivity will be determined.

The 1990 field season was a pilot effort designed 1) to evaluate survey techniques

for future use during Study 3-related work; 2) to provide support for Study 2 trapping and radio-telemetry efforts; and 3) to ensure continuity in prairie falcon and golden eagle population monitoring.

METHODS

Objectives 1-3: Golden Eagle and Prairie Falcon Surveys

Golden Eagles.--In 1990, 37 of 38 traditional golden eagle nesting territories in the SRBOPA and 22 of 28 territories in the Comparison Area (Fig. 1) were preselected for observation. All 59 territories were surveyed by helicopter or from the ground in conjunction with other raptor surveys.

Helicopter surveys were conducted from a Bell 206 Jet Ranger on 14 March and 4 June. The purpose of the first survey was to determine if territories were occupied and if eggs had been laid. Territories containing breeding pairs were re-checked during the second flight to assess productivity. Helicopter surveys in the SRBOPA were conducted along the Snake River from Givens Hot Springs east to Glenns Ferry, and along the Pacific Power and Light (PP&L) transmission line from miles 45 to 133. Helicopters were flown at speeds of 70-95 km/hr and we hovered approximately 10 m from nests for 5-25 sec to view nest contents. No attempt was made to flush incubating birds or count eggs.

Territories where occupancy or breeding status could not be ascertained during helicopter flights were subsequently surveyed from the ground. Ground surveys in 1990 were conducted in conjunction with prairie falcon density surveys in the SRBOPA and as independent efforts. Some nests in the Comparison Area were surveyed from the ground by Idaho Power Company personnel. Eagle pairs that showed no evidence of egg laying after repeated observations were categorized as "nonbreeding." A "breeding attempt" was confirmed if an occupied territory contained an incubating adult, eggs, young, or any indication that eggs had been laid (e.g., fresh eggshell fragments in fresh nesting material). A breeding attempt was "successful" if 1 or more young reached the age of 51 days (Steenhof 1987). A photographic aging key was used to age young (Hoechlin 1976). Eagle nests discovered after young had fledged were considered successful if 1) a platform decorated this season was worn flat and contained fresh prey remains; 2) fresh fecal matter covered the back and extended over the edge of the nest; and 3) no dead young birds were found within a 50-m radius of the nest.

Percent of pairs breeding in 1990 and earlier years was calculated from preselected pairs (Steenhof and Kochert 1982). Percent of nesting attempts that were successful was based on attempts confirmed during incubation.

Prairie Falcons.--In 1990, we tried to duplicate as nearly as possible the full-canyon density surveys performed in the SRBOPA between 1976 and 1978. A full-canyon survey allowed comparisons of overall falcon density as well as density in selected 10-km stretches surveyed between 1979 and 1988.

In 1990, 4 walking surveys of the Snake River Canyon and most side canyons were conducted from Walters Ferry east to Hammett (approximately 130 river km). Surveys were conducted from 21 March to 3 April; 20 April to 3 May; 14 May to 1 June; and 6 June to 22 June.

During density surveys, observers walked stretches of the canyon and stopped periodically to observe sections of cliff for periods of up to 15 min. Small and medium-sized cliffs were typically surveyed from the canyon rim; larger cliffs were surveyed from the base of the cliff. Observers sometimes

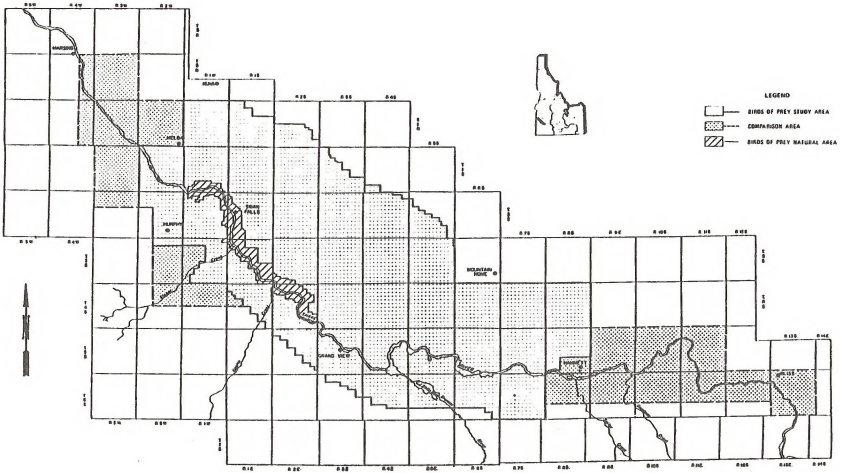

Fig.1. Location of the Birds of Prey Study Area (BPSA) and Comparison Area.

attempted to flush territorial birds by shouting, clapping hands, or tossing rocks from the cliff top. Nesting territories were considered occupied if territorial defense, courtship, or other reproductive activity was observed (U.S. Dep. Inter. 1990). Observers recorded the time of day, number of adults observed, number and age of young, presence of eggs, type of activity, nest location, and other pertinent data at each nest site visited. Young were aged using a photographic aging key (Moritsch 1983).

The locations of raptor sightings and nests were recorded on specially prepared forms containing a portion of the 7.5-min U.S.G.S. topographic map for a particular survey area. These forms were prepared for all reaches of the Snake River Canyon within the study area. Plotting of raptor sightings and nests was aided by 1:24,000-scale 1987 black and white aerial photographs cut to match the area covered by each form.

Reproductive performance of prairie falcons in the SRBOPA was assessed 1) for all pairs selected for Study 2 radio-telemetry work; 2) for a comparative sample of untrapped pairs; and 3) for additional pairs for which breeding attempts were confirmed during density surveys. These data allowed a comparison of productivity in 1990 with that of previous years and allowed a general assessment of productivity at trapped and untrapped sites. Productivity data were also provided to Study 2 personnel for the purpose of evaluating the effects of radio-telemetry work.

Study sites were selected from a list of sites where occupancy was confirmed during the March density survey. Initially, 30 sites (10 for backpack attachments, 10 for tailmounts, and 10 for a non-trapping control group) were randomly selected from this list. On 4 April, Study 3 personnel began intensive observations of these sites to locate scrapes of breeding pairs. Some sites where breeding pairs were not found or breeding had not been initiated were rejected. Sites were also rejected if nest climbs (for trapping purposes) were judged to be unsafe, if the scrape could not be accessed, or if subsequent trapping efforts failed. As sites were rejected, replacements were randomly selected from a list of sites known to be occupied at that time.

Nest climbs for trapping purposes by Study 2 personnel began on 16 April. Nest climbs at control sites by Study 3 personnel began on 17 April. All subsequent climbs for aging young and obtaining brood size at fledging were conducted by Study 3 personnel. Fledge counts were not obtained until young were at least 30 days old (Steenhof 1987). During nest climbs, all young were weighed, examined for condition, and banded on the right leg with a U.S. Fish and Wildlife Service leg band. They also received black alpha-numeric anodized aluminum bands on the left leg. The last nest climb for productivity assessment occurred on 20 June.

To compare productivity among years, sites where experimental disturbances, nest site enhancements, manipulations of eggs or young, trapping and tagging, and disease treatments occurred in 1990 or any year were excluded from the analysis. This was done to ensure that results were not biased by manipulations at nest sites. To assess the percent of breeding attempts that were successful, all breeding attempts confirmed during incubation for which outcome was known were included in the analysis. To assess the number of young fledged per successful attempt, all pairs for which complete fledge counts were obtained were included.

Objective 4: Quadrat Surveys

The study area for Objective 4 included the OTA and portions of the SRBOPA east and west of the OTA on the north side of the Snake River Canyon. Highway 51 formed the eastern boundary, and the Canyon County/Ada County Line formed the western

boundary. This study area was roughly equivalent to the Sunnyside Grazing Allotment (both spring-fall and winter ranges).

Sixteen 4-km^2 quadrats were surveyed during the study. Locations of quadrats were selected prior to the initiation of field work using a stratified random selection process based on IDARNG maneuver area categories. Four quadrats were selected in each of 4 areas: 1) the Firing Impact Area; 2) areas outside the Impact Area used primarily for tank manuevers; 3) areas outside the Impact Area including either a firing range or artillery firing point (areas exposed to both tank maneuvers and firing noise); and 4) areas outside the above 3 areas (i.e., outside the OTA).

We tried to select equal numbers of quadrats in grass, shrub, and grass/shrub habitats. Quadrats containing power lines were excluded to avoid biasing results toward quadrats containing artificial nesting substrates. This was done to assess differences in raptor densities in each of the habitat types. Four of the quadrats selected contained buttes, an important habitat feature for some ground-nesting raptors. All quadrats were inspected in the field prior to the initiation of surveys to confirm that selection criteria had been met. If criteria were not met, alternate sites were chosen. Centroids of each quadrat were marked with a steel fence post.

All 16 quadrats were surveyed twice. Surveys were conducted between 10-12 April and 7-9 May. Starting at the centroid, observers walked a series of transects at right angles to each other forming a widening square survey pattern. During each survey, observers paused at 100-m intervals to scan a belt of approximately 400 m on either side of the transect line for raptor activity. A compass was used to maintain the direction of transect lines. Observation intervals and lengths of transect lines were maintained by counting steps (the stride length of each observer was measured prior to the initiation of field surveys). When a nest was suspected, the observer flagged his or her position on the transect and left the transect line to inspect the site. To test the results of quadrat surveys against a more intensive search pattern, a 1-km^2 test-quadrat within 1 of the survey quadrats was searched thoroughly by 2 observers on foot on 25 May.

Objective 5: Validation Surveys

The purpose of these surveys was to compare the relative effectiveness of walking and point surveys during prairie falcon density work, and to make recommendations concerning the use of each in long-term monitoring of falcon density in the SRBOPA.

Twelve 2-km stretches of the Snake River Canyon were randomly selected in 3 cliff-height strata: <15 m; 15-30 m; and >30 m. Selected stretches were compared with maps of cliff-height strata prepared by Bentley and Hardyman (1978) to ensure that the entire 2-km stretch of each validation area fell within a single cliff-height category.

Validation stretches were surveyed by walking and point surveys 7 times in 1990. Four walking surveys were conducted in the course of prairie falcon density surveys, as described above. Point surveys were conducted independently of walking surveys but were scheduled as near as possible to the dates of walking surveys. Point surveys were conducted 3 times; in April, May, and June.

A total of 6 hrs of observation was conducted in each validation stretch during each point survey. In most cases, observations were conducted from 2 points within a validation stretch; thus, 1 km of cliff was surveyed. In cases where side draws or convolutions of the cliff prevented observations of 1-km portions, an additional observation point was used. Ten cliff stretches were observed from 2 observation

points; 2 were observed from 3 points. In all cases, observers divided their time equally between observation points. Most observations were conducted from the canyon floor; however, observations were made from the opposite canyon rim in 2 stretches where the view was obstructed from below. During walking surveys, mean observation time within validation stretches was 2.9 hrs.

RESULTS

Golden Eagles

Nesting Density.--In 1990, golden eagle pairs occupied 30 (81%) of the 37 preselected nesting territories in the SRBOPA. The number of occupied territories was the same as in 1989, but 2 less than in 1988 (Table 1). Eagle pairs occupied 19 (86%) of the 22 preselected territories in the Comparison Area. Of the 10 vacant territories in the SRBOPA and Comparison Area, 6 have not been occupied since 1982 or earlier. Of these, 3 (Bruneau Flats, Malad, and Simpkin) have not been occupied since 1978 or earlier. Two vacant territories (Strike II and Swan Dam) were vacant for the second consecutive year. One vacant territory (Delates Delight) had been occupied in 1988 and 1989.

Reproduction.--Golden eagle reproduction in the SRBOPA increased for the second consecutive year to its highest level since 1982 (Table 1). Percent of pairs breeding

Table 1. Nesting success and productivity of golden eagles in the SRBOPA, 1971-1990. Sample sizes are in parentheses.

Year	# of Occupied Territories	% of Pairs Breeding	% of Attempts Successful	# Fledged/ Successful Attempt	# Fledged Per Pair	Total # Fledged
1971	34	100% (31)	60% (20)	1.89 (19)	1.13	39
1972	34	---	---	1.64 (11)	---	---
1973	35	65% (34)	44% (18)	1.37 (8)	0.39	14
1974	35	73% (30)	56% (18)	1.42 (12)	0.58	20
1975	33	75% (32)	56% (18)	1.43 (14)	0.60	20
1976	35	70% (33)	47% (15)	1.62 (13)	0.53	19
1977	34	82% (33)	59% (17)	1.53 (15)	0.74	25
1978	32	80% (30)	70% (10)	1.71 (17)	0.96	31
1979	30	97% (30)	61% (23)	1.53 (19)	0.91	27
1980	31	87% (31)	72% (18)	1.77 (22)	1.11	34
1981	30	100% (30)	74% (23)	1.73 (22)	1.28	38
1982	30	87% (30)	80% (25)	1.95 (19)	1.36	41
1983	28	96% (27)	72% (18)	1.56 (16)	1.07	30
1984	31	---	61% (18)	1.55 (11)	0.60[1]	19
1985	32	39% (31)	42% (12)	1.00 (4)	0.16	5
1986	29	54% (28)	29% (14)	1.33 (6)	0.21	6
1987	32	78% (32)	32% (25)	1.38 (8)	0.34	11
1988	32	74% (31)	55% (22)	1.54 (13)	0.63	20
1989	30	80% (30)	63% (19)	1.36 (14)	0.69	21
1990	30	87% (30)	80% (25)	1.65 (20)	1.15	33

[1] based on % of pairs successful

increased from 80% in 1989 to 87% in 1990, and percent of breeding attempts successful increased from 63% to 80% between those years. The number of young fledged per successful nesting attempt increased from 1.36 to 1.65, and number of young fledged per pair increased from 0.69 to 1.15 between 1989 and 1990.

Golden eagle reproduction in the SRBOPA was higher than in the Comparison Area for the first time since 1983 (Table 2). Although the percent of pairs breeding was slightly higher in the Comparison Area than in the SRBOPA (89% vs. 87%), the percent of breeding attempts successful and number of young fledged per pair were substantially higher in the SRBOPA than in the Comparison Area (80% vs. 63% and 1.15 vs. 0.92, respectively). The differences between the SRBOPA and Comparison Area in 1990 reflect a sharp increase in productivity in the SRBOPA since 1989 as compared to a slight increase in the Comparison Area. In the SRBOPA, percent of breeding attempts successful increased from 63% to 87% and number of young fledged per pair increased from 0.69 to 1.15 between 1989 and 1990. In the Comparison Area, the percent of breeding attempts successful and young fledged per pair increased only slightly from 61% in 1984 to 63% in 1990 and from 0.81 to 0.92, respectively.

Prairie Falcons

Nesting Density.--We located 185 occupied prairie falcon territories in the SRBOPA in 1990. This represents a slight increase from the 182 pairs found during the last complete survey in 1978. However, the number of pairs found in 1990 was lower than in 1976 and 1977 when 205 and 206 pairs, respectively, were found.

In 1990, 79 occupied prairie falcon territories were found in the 8 randomly selected 10-km stretches surveyed (Table 3). This total is slightly higher than the mean number of occupied territories found between 1976 and 1978. The total number of occupied territories found in 1990 was also higher than in 1986 and 1988.

The increase in occupied territories in 1990 did not occur uniformly throughout the selected stretches. In Units 6 and 7, the number of territories found was higher than in 1986 and 1988. In Unit 7 the number of territories found in 1990 was higher than in any previous year. However, the number of occupied territories occupied in Unit 15 was lower than in all previous years. Overall, numbers increased in 2 stretches, decreased in 4 stretches, and remained the same in 1 stretch from 1988 to 1990.

Table 2. Nesting success and productivity of golden eagles in southwestern Idaho, 1990. Sample sizes are in parentheses.

Study Area	% of Pairs Breeding	% of Attempts Successful	# Fledged/ Successful Attempt	# Fledged Per Pair
SRBOPA	87% (30)	80% (25)	1.65 (20)	1.15
Comparison	89% (19)	63% (16)	1.64 (11)	0.92

Table 3. Number of occupied prairie falcon territories in randomly selected 10-km units in the SRBOPA, 1976-78, 1986, 1988, and 1990.

10-Km Unit	1976	1977	1978	1976-1978 Mean	1986	1988	1990
3	0	0	1	(0.3)	0	1	1
6	32	32	30	(31.3)	23[1]	28	32
7	13	12	14	(13.0)	12	10	15
8	13	12	9	(11.3)	10	16	13
15	13	13	12	(12.7)	13	13	10
24	3	4	2	(3.0)	2	4	3
26	4	5	3	(4.0)	1	4	3
37	3	3	2	(2.7)	3	2	2
Total	81	81	73	78.3	64	78	79

[1] Surveys of the south side of the river between the mouth of Sinker Creek and Balls Line West may have been incomplete in 1986.

In 1990, 38 pairs were found in 3 units (7, 8, and 15) that were surveyed each year from 1976 to 1984 (Table 4). This 1990 total was higher than the 12-year average (36.6). The number of pairs found in Unit 7 in 1990 was higher than in all previous years, with the exception of 1981. In 1990, the number of pairs in Unit 8 was higher and in Unit 15 was lower than the 12-year average in each case.

Productivity.--In 1990, productivity of prairie falcons in the Snake River Birds of Prey Area was slightly higher than the mean for 1974-1990. Seventy-four percent of all nesting attempts were successful (compared to a mean of 71%); the number of young fledged per successful attempt was 4.06 (compared to a mean of 3.82); and the number of young fledged per attempt was 3.00 (compared to a mean of 2.75) (Table 5). The number of young fledged per successful attempt in 1990 was higher than in 13 of the previous 16 years.

Nesting success at trapped sites was lower than that of untrapped sites, though the difference was not significant ($\chi^2 = 0.22$, $P = 0.72$). Sixty-two percent of nesting attempts at trapped sites were successful, compared to 70% at untrapped sites and 71% for all years (Table 6). The number of young fledged per successful attempt at trapped sites was 4.07, compared with 4.50 at untrapped sites, though the difference was not significant (Mann-Whitney $U = 39$, $P = 0.61$). The number of young fledged per attempt at trapping sites was 2.44, compared with 3.00 at untrapped sites and 2.75 for all years. The number of young fledged per successful nesting attempt at trapped sites was higher than the mean for all years (4.07 vs. 3.82).

Mean fledging weights at sites where adults were radioed in 1990 were lower than at undisturbed sites (nested analysis of variance , 1-sided $P = 0.05$ for radio effects). Both sexes were included in the hierarchical analysis. Male fledgling weights averaged 555 g ($n = 17$) at radioed sites and 567 g ($n = 17$) at undisturbed sites. Female fledglings averaged 795 g ($n = 15$) at radioed sites and 876 g ($n = 8$) at undisturbed sites.

Table 4. Number of occupied prairie falcon territories in 10-km survey units 7, 8, and 15 in the SRBOPA.

Year	7	8	15	Total
1976	13	13	13	39
1977	12	12	13	37
1978	14	9	12	35
1979	14	10	12	36
1980	13	11	10	34
1981	16	13	12	41
1982	12	11	10	33
1983	11	15	9	35
1984	12	10	15	37
1986	12	10	13	35
1988	10	16	13	39
1990	15	13	10	38
Mean	11.6	11.6	11.9	36.6

Table 5. Nesting success and productivity of prairie falcons in the SRBOPA, 1974-1990. Sample sizes are in parentheses.

Year	% of Attempts Successful	# Fledged/ Successful Attempt	# Fledged/ Attempt
1974	64% (11)	3.94 (17)	2.52
1975	86% (21)	3.74 (27)	3.21
1976	79% (29)	4.00 (41)	3.16
1977	67% (27)	4.08 (25)	2.73
1978	18% (17)	3.29 (17)	0.59
1979	75% (32)	3.73 (30)	2.80
1980	65% (54)	4.03 (36)	2.62
1981	83% (46)	4.04 (22)	3.35
1982	69% (26)	3.53 (17)	2.44
1983	73% (26)	3.24 (17)	2.36
1984	88% (16)	3.95 (19)	3.48
1985	93% (14)	4.08 (13)	3.79
1986	44% (18)	3.43 (7)	1.51
1987	72% (36)	4.32 (31)	3.11
1988	78% (9)	3.86 (7)	3.01
1989	83% (6)	3.67 (6)	3.05
1990	74% (19)	4.06 (18)	3.00
Mean All Years	71% (24)	3.82 (21)	2.75

Table 6. Nesting success and productivity of preselected prairie falcons in 1990. Numbers in parentheses are sample sizes.

Group	% of Attempts Successful	# Fledged/ Successful Attempt[1]	# Fledged/ Attempt[1]
Trapped Sites	62% (26)	4.07 (15)	2.44 (25)
Untrapped Sites (control group)	70% (10)	4.50 (6)	3.00 (9)
All Sites	64% (36)	4.19 (21)	2.59 (34)
Mean, All Years[2]	71%	3.82	2.75

[1] Incomplete fledge counts at Rattlesnake Canyon and Corral Downstream were not included in these calculations.

[2] Mean calculated for all years 1974-1990. (Table 5)

Although these data suggest a possible problem with radios, they are inconclusive and should be viewed with caution. First, birds were sexed ocularly on the basis of tarsal width, and no measurements other than weight were taken. Second, although all birds were weighed when they were 30-35 days of age, ages were estimated using photographic aging keys. Problems associated with sexing and aging should have been distributed equally among the 2 groups, but quantitative measurements (footpad length, tarsal diameter and length of 7th primary) should be taken in future years to verify sex and age. Future analyses should also consider brood size even though it did not appear to be an important factor in the 1990 results.

Ground-Nesting Raptors

During 32 quadrat surveys, only 4 occupied raptor nests were found. A total of 33.1 hrs was expended in conducting the surveys, or 8.3 hrs per nest. Raptor nests found included 2 burrowing owl (*Athene cunicularia*) nests, a ferruginous hawk nest, and a Swainson's hawk (*Buteo swainsoni*) nest (Table 7). No raptor nests were found during the quadrat-test survey.

Results of the quadrat study indicate that raptor nests on the plateau are patchily distributed and occur at low densities. Thus, quadrat- or transect-based methods may not provide numbers suitable for direct statistical comparison of nest abundance on vs. off the OTA. Survey efforts could focus on a greater number of smaller quadrats, which would provide better coverage of a variety of habitat types but contain more zero counts, or a fewer number of larger quadrats, which would have few zero counts but provide limited coverage. However, the increase in quadrat number or size would require a substantial increase in sampling effort and associated labor and costs. The increased effort would probably not be reflected in a substantial improvement in survey results.

Validation Surveys

General Survey Results.--Of 54 traditional prairie falcon territories known to occur in the 12 validation stretches, 39 were occupied

Table 7. Results of 16 quadrat surveys of ground nesting raptors in the SRBOPA, 1990.

Strata	No. of Quadrats	Total Survey Time (hrs)	Nests Found	Habitat
Impact Area	4	9.7	1 FH	Grassland
Tracking Area	4	9.1		Sagebrush and Grassland
Tracking/ Firing Area	4	7.2	2 BuO	Sagebrush and Grassland
Outside the Impact Area	4	7.1	1 SH	Sagebrush and Grassland
Total	16	33.1	4	

FH - ferruginous hawk, BuO - burrowing owl, SH - Swainson's hawk

by territorial pairs in 1990. Of these, 38 were found during the 7 walking and point surveys. One pair was found incidentally during other survey work.

Of 39 falcon pairs found during all surveys, 32 (82.0%) were found during 4 walking surveys, and 33 (84.6%) were found during 3 point surveys (a point survey was not conducted in March) (Table 8). These results indicate that a majority of falcon pairs will be found at least once during repeated surveys regardless of the survey method used. In both cases, some pairs were missed. However, point surveys were more effective overall (more pairs were found during fewer surveys).

Effects of Cliff Height.--Of 39 pairs of falcons found during all surveys, 7 were found in the <15 m cliff-height category; 12 were found in the 15-30 m category; and 20 were found in the >30 m category (Table 8). Within all cliff-height categories, the majority of falcon pairs present were found during the 4 walking and 3 point surveys. This suggests that most pairs will be found at least once during repeated surveys, regardless of cliff height. However, if the March walking survey is excluded, a greater number of pairs were found during point surveys than walking surveys for each of the cliff-height categories.

Monthly Survey Results.--Monthly point survey results were consistently higher than those of walking surveys. During the April walking survey, only 23.1% of all falcon pairs in all strata were found compared to 53.8% during the April point survey. The results of the May and June surveys also show a greater percentage of pairs found during point surveys as opposed to walking surveys, though the differences were less than in April (Table 9). The trend towards higher counts during point surveys was also evident in the cliff-height strata breakdowns. Point counts were higher in all months and cliff height strata with the exception of the June survey in the >30-m category.

Numbers of pairs found late in the breeding period tended to be higher than those found early in the breeding period for both walking

Table 8. Number and percent of 39 prairie falcon pairs found during walking and point surveys for 3 cliff-height strata and all strata combined.

Cliff Height	Walking		Walking (Excluding March)		Point		Total Pairs
	#	%	#	%	#	%	
< 15 meters	5	71.4	4	57.1	5	71.4	7
15-30 meters	10	83.3	9	75.0	11	91.7	12
> 30 meters	17	85.0	16	80.0	17	85.0	20
All Strata	32	82.0	29	74.4	33	84.6	39

and point surveys. In addition, April survey results tended to be lower than those of other months, especially with walking surveys. During walking surveys, the percent of pairs found in all strata decreased from 35.9% in March to 23.1% in April. During point surveys, percent of pairs found in April for all strata was the lowest of any month (Table 9).

Survey results during particular months correspond well with the type and amount of falcon activity which would be expected during the corresponding phase in the breeding cycle. The increase in the percent of pairs found through the breeding period, observed for both walking and point surveys, reflects the increasing activity at nests. In March, during courtship, pairs are conspicuous in their breeding territories as they search for an appropriate nesting site and interact with other falcons and other raptors. However, some pairs will begin breeding later and will be missed during March surveys. In April, during the incubation period, falcons are less likely to flush upon approach during walking surveys or to be seen during point surveys. In May, during the brood-rearing period, both adults must hunt and deliver prey to the nest.

Table 9. Number and percent of 39 prairie falcon pairs found during monthly walking and point surveys for 3 cliff-height strata and all strata combined.

Walking	March		April		May		June		Total Pairs
	#	%	#	%	#	%	#	%	
< 15 m cliff	3	42.9	1	14.3	1	14.3	3	42.9	7
15-30 m cliff	6	50.0	2	16.7	5	41.7	5	41.7	12
> 30 m cliff	5	25.0	6	30.0	10	50.0	13	65.0	20
All Strata	14	35.9	9	23.1	16	41.0	21	53.8	39
Point									
< 15 m cliff	N/A		2	28.6	2	28.6	4	51.7	7
15-30 m cliff	N/A		7	58.3	11	91.7	8	66.7	12
> 30 m cliff	N/A		12	60.0	11	55.0	12	60.0	20
All Strata	N/A		21	53.8	24	61.5	24	61.5	39

Thus, the likelihood of detection increases. Finally, in June, during the fledging period, young falcons have left the nest but remain close to the nest site. Thus, the likelihood of detection becomes even greater as adults continue to deliver food and young interact between prey deliveries.

Timing of surveys and the survey method used during a particular phase in the breeding cycle should be important considerations in planning surveys. For example, the percent of pairs in all cliff-height strata found during the April walking survey (23.1%) was the lowest of any survey conducted. Results of the April point survey, on the other hand, were much higher (53.8%). The increased effectiveness of the April point survey is probably related to the length of the observation period in point surveys. A longer observation period during incubation will allow a greater possibility of observing the infrequent interactions between birds which characterize that phase of the breeding cycle.

Relative Investment and Return of Point and Walking Surveys.--Although the number of pairs found during point surveys was higher than during walking surveys in all months and all cliff height strata (with the exception of the June survey in the >30-m cliff-height category), the investment of time during point surveys was higher than during walking surveys. Each 2-km validation stretch was surveyed for 6 hrs during point surveys (2 3-hr periods), compared to a mean of 2.9 hrs during walking surveys (Table 10). Thus, the return per unit effort (pairs found per hr) is higher in the case of walking surveys. A mean of 0.43 pairs per hr were found during walking surveys, compared to 0.32 pairs per hr for point surveys (Table 10).

Most or all pairs found during point surveys at all observation points were found in the first 2 hrs of observation (Fig. 2). All pairs found during point surveys in the <15 m and 15-30 m categories and 88% of pairs found in the >30 m category were found in the first 2

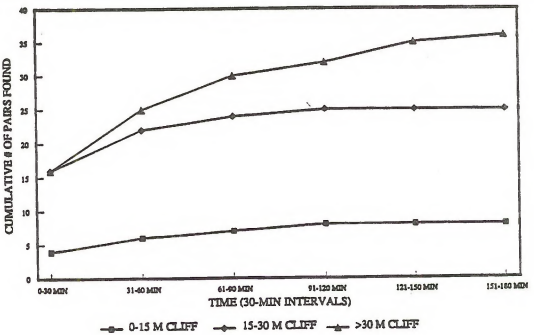

Fig. 2. Number of falcon pairs found during point survey time intervals.

Table 10. Comparison of relative investment (time/2-km stretch), return (no. pairs found), and return/unit effort (pairs found/hour) for walking and point surveys in 12 2-km validation stretches. For point surveys, 6-hr and 4-hr surveys are compared.

Walking	March	April	May	June	Mean All Months
Hrs/2-km Stretches	3.1	2.9	2.8	2.8	2.9
No. Pairs Found All Stretches	14	9	16	21	15
No. Pairs/Hr	0.37	0.26	0.48	0.62	0.43
Point (6 Hrs/2-km Stretch)	March	April	May	June	Mean All Months
Hrs/2-km Stretch		6	6	6	6
No. Pairs Found All Stretches		21	24	24	23
No. Pairs/Hr		0.29	0.33	0.33	0.32
Point (4 Hrs/2-km Stretch)[1]	March	April	May	June	Mean All Months
Hrs/2-km Stretch		4	4	4	4
No. Pairs Found All Stretches		19.5	22.3	22.3	21.4
No. Pairs/Hr		0.41	0.46	0.46	0.44

[1] Adjusted for 7% reduction in the number of pairs found during 4 hrs of observation as compared with 6 hrs (See Page 25).

hrs. Thus, we found 93% of all pairs in all strata in the first 2 hrs during point surveys. If the results of point surveys within the 12 validation stretches are adjusted for 4-hr observation periods (2 2-hr periods), the return per unit effort increases to 0.44 pairs per hr (Table 10). Thus, overall, point surveys will be slightly more effective than walking surveys in assessing falcon density if observations are limited to 2-hr periods.

Banding and Marking

During 1990, 334 raptors were banded with aluminum U.S. Fish and Wildlife Service bands. This included 1 golden eagle, 100 prairie falcons, 36 ferruginous hawks, 79 American kestrels (*Falco sparverius*), 20 long-eared owls (*Asio otus*), 52 western screech-owls (*Otus kennicottii*), and 46 northern saw-whet owls (*Aegolius acadicus*). The eagle was banded as a nestling at Crater Rings. Of the prairie falcons, 80 were banded as nestlings, and 20 were adults. Out of the 20 adults banded, 16 received radio transmitters and 4 received leg bands only. In addition, 2 adult prairie falcons, that had been banded in previous years received radio transmitters (see below). Nestling prairie falcons also received black anodized bands on the left leg; adults received similar bands on the right leg. All ferruginous hawks were banded as nestlings. Banding details for American kestrels, long-eared owls, western screech owls, and northern saw-whet owls are provided in other sections of this annual report.

Band Recoveries and Sightings of Marked Birds.--One of the prairie falcons banded as a nestling in 1990 was captured and released in December 1990, 40 km north of its natal area (Mac the Knife). Two prairie falcons and 1 red-tailed hawk banded in previous years were encountered in 1990. We also recorded 1 sighting of a color-marked prairie falcon. Two prairie falcons banded as nestlings in 1987 were recaptured as adults during Study 2 radio-telemetry efforts. A male prairie falcon banded as a nestling at the Falcon Flats Cave eyrie was captured at the Narrows territory 35.6 km southeast of the banding location. A second male banded as a nestling at the Falcon Flats Fireman eyrie was captured 7 km southeast of the banding location at the Tick II territory. The red-tailed hawk was banded as a nestling in 1979 at Swan 1 Draw and found dead in Arizona of unknown cause. A fourth prairie falcon, an adult wearing a blue or green leg band, was observed by Study 2 personnel for a 3-day period in May delivering prey to a nesting territory (Fawn Draw) occupied by 2 other adults. Based on the alpha numeric on the leg band, we believe the bird was wearing a blue leg band and was banded as a nestling in 1987 at the Balls Basin Hamer territory, approximately 29 km northwest of Fawn Draw.

ACKNOWLEDGMENTS

We thank Leslie Carpenter, Glenn Stewart, Natalene Cummings, Dan Taylor, Sara Possehl, Dan Stevenson, Chuck Kilpatrick, and Tom Weiss for their invaluable assistance in the field.

Idaho Power Company provided housing for field crews at Swan Falls Dam and conducted golden eagle observations in the Comparison Area. We thank Rick Kirtley at Swan Falls for his hospitality and Toni Holthuijzen for the golden eagle observations. Ken Burnham, Colorado State University, Fort Collins, provided statistical advice. Thanks go to Idaho Helicopters and our pilots Randy Mason and Will Eldredge for flying golden eagle helicopter surveys. We thank Dave Clugston and all Study 2 personnel for their cooperation in all phases of this study.

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Raptor Distribution and Use of the Orchard Training Area (OTA) and Adjacent Areas: Pilot Study

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Annual Summary

A series of 178 30-min raptor and raven counts were conducted in the tall-shrub, grass-exotic annual, and winterfat habitats of the SRBOPA. Point counts were conducted equally in 3 diurnal periods: morning (sunrise - 1100 hrs), afternoon (1100 - 1600 hrs), evening (1600 hrs - sunset). To achieve > 50% non-zero counts, observations need to be at least 20 min long and cover a minimum distance of 1000 m.

OBJECTIVES:

1. Explore and map roads, firebreaks, etc., suitable for an observer to drive for point counts.

2. Establish an appropriate radius for point counts by answering the following questions: i) Can the frequency of non-zero counts be increased by increasing the radius? ii) What is the limit of visibility at most sites?

3. Establish whether 10-min observation periods are adequate to produce at least 25% non-zero counts, ideally 50-70% non-zero, of all species combined.

4. i) Determine the probabilities of observing each pre-defined behavior within 10-min intervals up to 30 min, ii) establish a behavioral catalogue and how behavior data may be lumped into categories for further analysis; establish criteria for hunting behavior.

5. Establish how behavioral data can be collected and recorded if several birds are present.

6. Compare observers to determine whether observer differences will have an effect on data interpretation.

7. Using information collected in the above objectives, develop a study plan for Study 1 in subsequent years.

INTRODUCTION

BLM/Idaho Army National Guard (IDARNG) Study 1 is described in the "Research Plan to Assess the Impacts of Habitat Alteration in the Snake River Birds of Prey Area, 15 August 1989 Revision." This study will provide information about the

probability that a given tract of land within the OTA will be used by a certain species of raptor under a given set of conditions (season, time of day, presence/absence of military activity, etc.). This information will allow managers to schedule military training for time periods and locations that will have minimal impacts on birds of prey. It will also allow them to prioritize areas for habitat protection and/or restoration.

In Study 1, information will be gathered on all species of diurnal raptors and ravens during all seasons and on nonbreeders and/or sub-adults not tied to nesting sites in the canyon. Data collected in this study will complement telemetry data collected on individual raptors in Study 2. The following Pilot Study is intended to provide information to allow tighter study design of the intensive phase of Study 1.

METHODS

Roads, firebreaks, and tracks were located from aerial photographs taken in 1987 and ground checked by driving every track. All driveable tracks located within the study area were plotted on 1:24,000 maps from aerial photos using a color code scheme to denote the quality of the track. Fences and power lines were also plotted.

Observation sites were located in each of 3 habitat types (tall-shrub, winterfat, and grass) within the study area of the Snake River Birds of Prey Area (SRBOPA). This includes the entire SRBOPA west of Bruneau Bridge and north of the canyon rim (Fig. 1). By driving through the larger tracts of each habitat and stopping at 1- to 1.5-km intervals, sites were chosen where visibility was at least 1500 m in all directions. Two sets of observation sites were located inside and outside the Orchard Training Area (OTA) respectively (Table 1).

At each site, an observer recorded the habitat type, weather (wind speed and direction, temperature, sky cover), and time of day that observations began. The observer then systematically looked for all raptors and ravens for a period of 30 min. Observations were made by scanning the horizon through 10 x 40 binoculars in 90 degree quadrants with a brief period of general looking around without binoculars between quadrants. For every raptor or raven seen, the following data were recorded: species (if identifiable, otherwise it was recorded as "unidentified raptor"), time observed, distance from observer (estimated from rangefinder measurements of ground features at each site), habitat that the bird was flying over (described as either sagebrush, grass/exotic annuals, winterfat, rock, unknown, or a combination of these descriptors), behavioral action when first observed (Table 2), and other comments (such as the outcome of the behavior seen). Observations were repeated at each site in

Table 1. Number of observation sites and observation periods in each habitat inside and outside the Orchard Training Area (OTA).

	Inside OTA		Outside OTA	
Habitat	Obs. Sites	Obs. Periods	Obs. Sites	Obs. Periods
Tall-shrub	11	33	15	33
Grass/exotic annual	11	33	17	33
Winterfat	0	0	6	18

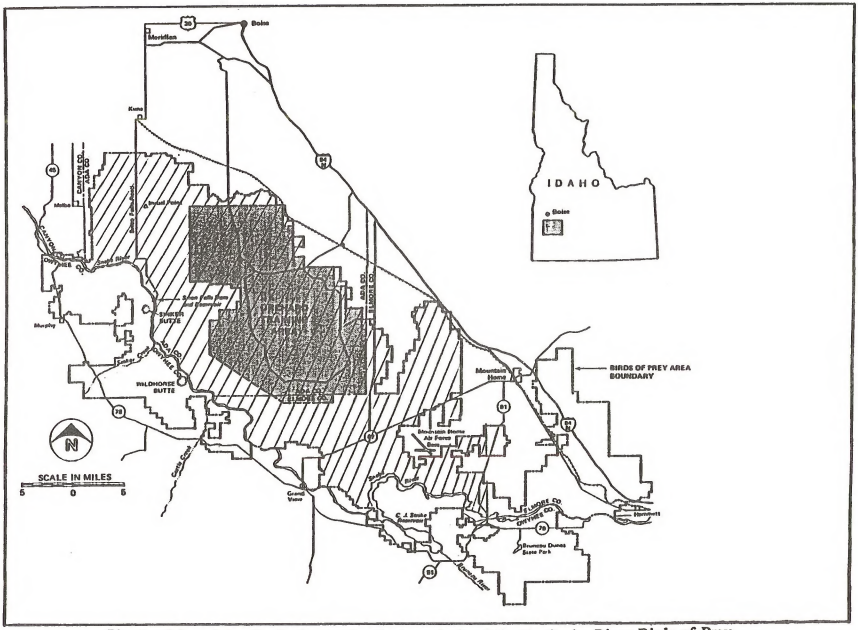

Fig. 1. Map of the Study 1 area (hatched portion) within the Snake River Birds of Prey Area.

Table 2. Behavior descriptions, with data sheet codes, in 2 levels of complexity.

Level 1: Simple Actions

Code	Action	Description
FL	FLAPPING FLIGHT	flapping flight
GL	GLIDING FLIGHT	gliding flight, with loss in altitude
SO	SOAR	gliding in circles or similar pattern with a gain in altitude
DV	DIVE	rapid loss of altitude (more rapid than normal glide for the species)
HO	HOVER	flight with no ground speed
PE	PERCH	inactive or active, on the ground or an elevated position, i.e. anything but flying

Level 2: Multiple Actions

Code	Action	Description
MA	MANEUVERS, INTRASPECIFIC	multiple, rapid changes of position and flying while interacting with same species
ME	MANEUVERS, INTERSPECIFIC	multiple, rapid changes of position and flying while interacting with a different species
MI	MANEUVERS, INDIVIDUAL	multiple, rapid changes of position and flying while alone (DISPLAY)
FE	FEEDING	eating prey
CP	CARRYING PREY	flight with prey in talons
PP	PURSUING PREY	characteristic flight pattern for species when chasing down prey, ending with a talon strike; e.g. for prairie falcon flight would be low level and rapid ending with a ground strike

Altitude

Prefix		Suffix	
Code	Description	Code	Description
FX	Fixed altitude	0	On the ground
AS	Ascending	1	>0 to 10m
DE	Descending	2	>10 to 30m
		3	>30m

each of 3 diurnal time periods: sunrise to 1100, 1100 to 1600, and 1600 to sunset.

An additional 30 observation sites were located randomly throughout the study area by plotting map-coordinates generated from random numbers. Observations were made once at each site by 2 observers working simultaneously but independently of each other. Range of visibility (distance to horizon) was also recorded at each random site in each of 4 cardinal directions.

RESULTS

A total of 9600 km (6,000) miles was driven through the study area in order to locate all driveable roads and conduct 178 half-hr counts. On average, it took 16 person-hrs to do 10 counts, with 2 observers counting separate sites; simultaneous counts required 16 person-hrs to achieve 5 counts.

Road maps

Maps of roads, firebreaks, tracks, fences and power lines within the study area of the SRBOPA are on file at the BLM in 18 1:24000 maps, each 70 x 50 cm.

Non-zero counts

The frequency (percentage) of non-zero counts among all observation sites increased as both the time observed and distances at which birds were recorded increased (Tables 3-6). For example, considering all species in all habitats, a non-zero count percentage of greater than 50% was achieved within the first 10 min if all birds seen (regardless of distance) were counted. If the distance was limited to within 1000 m, then observations had to continue for 20 min before achieving a >50% non-zero count. If distance was limited to within 500 m, then the percentage of non-zero counts at the maximum time limit of 30 min was 39.3%. A maximum sighting radius of 500 m therefore is too small to achieve the preferred 50-75% non-zero count. Eight raptors were unidentifiable within each distance interval of 0 to 500 m ($\underline{n}$ = 128) and 500 to 1000 m ($\underline{n}$ = 157). Beyond 1000 m the number unidentified was 4 times greater ($\underline{n}$ = 121). Therefore, 1000 m should be a maximum sighting radius for point counts.

To estimate the percentage of non-zero counts expected from a random sample of observation sites within the study area, the data for each of the major habitat types must be adjusted for the relative proportion of each habitat in the study area. This was done by separately multiplying percentage non-zero count data for each habitat by the proportion of that habitat in the study area and summing the results (Tables 7, 8). The proportion of each habitat type in the study area was derived from the Bureau of Land Management GIS vegetation map. At random sites within the OTA, a 20-min observation period would be required to obtain > 50% non-zero counts of all species at a sighting radius of up to 1000 m (Table 7). The same result is obtained for sites selected randomly within the entire study area (Table 8).

Limit of visibility

The range of visibility at random sites was > 1500 m in all directions at 54% of sites. Visibility was restricted to < 1000 m in 2 directions at 27% of sites, in 1 direction at 12%, and in 3 or all directions at 3.5% of sites respectively. Of 104 cardinal points for which visibility range was recorded, 78% were > 1500 m (Fig. 2). The distribution of visibility limits was bimodal (Fig. 2), suggesting that a shift of observers position of 200 to 400 m would improve visibility to > 1000 m at most sites.

Behavior

In discussion with Study 2 personnel, and based on our field observations, we concluded that raptor behavior should be described by actions without subjective interpretation of the motive for the behavior

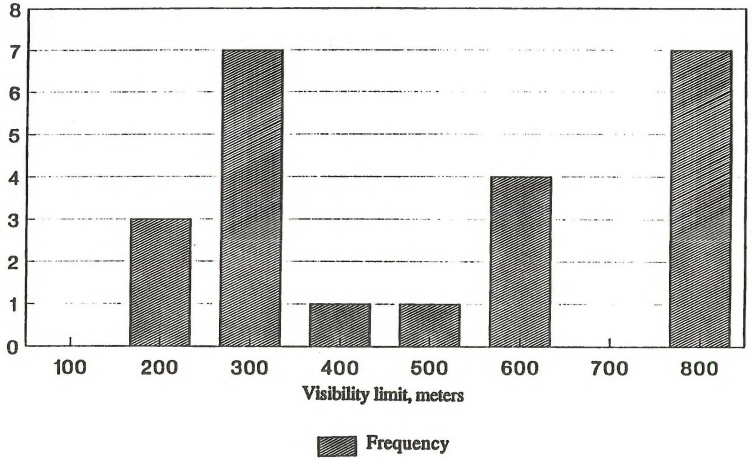

Fig. 2. Frequency of visibility limits at 26 sites in each of 4 cardinal directions (n = 104).

Table 3. The number and percentage of non-zero counts made during 150 observation periods in all habitats collectively.

Species	Time	Number			Percentage		
		<500m	<1000m	>1000m	<500m	<1000m	>1000m
ALL	10	38	69	85	25	46	57
ALL	20	55	90	108	37	60	72
ALL	30	59	97	116	39	65	77
RA	10	19	30	40	13	20	27
RA	20	21	41	56	14	27	37
RA	30	21	46	68	14	31	45
GE	10	4	18	22	3	12	15
GE	20	8	23	30	5	15	20
GE	30	8	25	37	5	16	25
PF	10	6	14	16	4	9	11
PF	20	12	28	31	8	19	21
PF	30	16	39	43	11	26	29
RT	10	4	7	8	3	5	5
RT	20	9	13	15	6	9	10
RT	30	12	18	20	8	12	13
FH	10	0	3	4	0	2	3
FH	20	3	7	8	2	5	5
FH	30	4	10	12	3	7	8
NH	10	5	9	9	3	6	6
NH	20	10	16	16	7	11	11
NH	30	11	19	19	7	13	13
SH	10	0	0	0	0	0	0
SH	20	0	0	0	0	0	0
SH	30	0	0	0	0	0	0
TV	10	0	0	1	0	0	1
TV	20	2	3	4	1	2	3
TV	30	2	4	5	1	3	3
SO	10	0	1	1	0	1	1
SO	20	2	3	3	1	2	2
SO	30	3	3	3	2	2	2
BO	10	2	2	2	1	1	1
BO	20	2	2	2	1	1	1
BO	30	2	2	2	1	1	1

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

Table 4. The number and percentage of non-zero counts made during 66 observation periods in tall-shrub/mixed-shrub habitats.

Species	Time	Number			Percentage		
		<500m	<1000m	>1000m	<500m	<1000m	>1000m
ALL	10	13	26	33	23	46	59
ALL	20	25	41	48	45	73	86
ALL	30	26	45	49	46	80	88
RA	10	8	13	15	14	23	27
RA	20	10	18	24	18	32	43
RA	30	10	21	30	18	38	54
GE	10	2	6	7	4	11	13
GE	20	4	9	12	7	16	21
GE	30	4	11	17	7	20	30
PF	10	1	4	5	2	7	9
PF	20	5	12	13	9	21	23
PF	30	8	19	20	14	34	36
RT	10	0	2	3	0	4	5
RT	20	2	5	6	4	9	11
RT	30	5	9	10	9	16	18
FH	10	0	2	3	0	4	5
FH	20	1	4	5	2	7	9
FH	30	1	5	6	2	9	11
NH	10	2	4	4	4	7	7
NH	20	5	8	8	9	14	14
NH	30	6	11	11	11	20	20
SH	10	0	0	0	0	0	0
SH	20	0	0	0	0	0	0
SH	30	0	0	0	0	0	0
TV	10	0	0	0	0	0	0
TV	20	1	1	1	2	2	2
TV	30	1	1	1	2	1	2
SO	10	0	0	0	0	0	0
SO	20	2	2	2	4	4	4
SO	30	2	2	2	4	4	4
BO	10	0	0	0	0	0	0
BO	20	0	0	0	0	0	0
BO	30	0	0	0	0	0	0

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

Table 5. The number and percentage of non-zero counts made during 66 observation periods in grass/exotic annuals habitat.

Species	Time	Number			Percentage		
		<500m	<1000m	>1000m	<500m	<1000m	>1000m
ALL	10	16	31	37	21	41	49
ALL	20	19	34	44	25	45	58
ALL	30	22	37	51	29	49	67
RA	10	7	12	17	9	16	22
RA	20	7	16	22	9	21	29
RA	30	7	18	28	9	24	37
GE	10	2	10	11	3	13	14
GE	20	4	12	14	5	16	18
GE	30	4	12	16	5	16	21
PF	10	2	5	6	3	7	8
PF	20	4	11	13	5	14	17
PF	30	5	15	18	7	20	24
RT	10	1	2	2	1	3	3
RT	20	2	3	4	3	4	5
RT	30	2	4	5	3	5	7
FH	10	0	1	1	0	1	1
FH	20	2	3	3	3	4	4
FH	30	3	5	5	4	7	7
NH	10	3	5	5	4	7	7
NH	20	5	8	8	7	11	11
NH	30	5	8	8	7	11	11
SH	10	0	0	0	0	0	0
SH	20	0	0	0	0	0	0
SH	30	0	0	0	0	0	0
TV	10	0	0	0	0	0	0
TV	20	0	0	0	0	0	0
TV	30	0	0	0	0	0	0
SO	10	1	1	1	1	1	1
SO	20	1	1	1	1	1	1
SO	30	1	1	1	1	1	1
BO	10	2	2	2	3	3	3
BO	20	2	2	2	3	3	3
BO	30	2	2	2	3	3	2

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

Table 6. The number and percentage of non-zero counts made during 18 observation periods in winterfat habitat.

Species	Time	Number			Percentage		
		<500m	<1000m	>1000m	<500m	<1000m	>1000m
ALL	10	9	12	15	50	67	83
ALL	20	11	15	16	61	83	89
ALL	30	11	15	16	61	83	89
RA	10	4	5	8	22	28	44
RA	20	4	7	10	22	39	56
RA	30	4	7	10	22	39	56
GE	10	0	2	4	0	11	22
GE	20	0	2	4	0	11	22
GE	30	0	2	4	0	11	22
PF	10	3	5	5	17	28	28
PF	20	3	5	5	17	28	28
PF	30	3	5	5	17	28	28
RT	10	3	3	3	17	17	17
RT	20	5	5	5	28	28	28
RT	30	5	5	5	28	28	28
FH	10	0	0	0	0	0	0
FH	20	0	0	0	0	0	0
FH	30	0	0	1	0	0	6
NH	10	0	0	0	0	0	0
NH	20	0	0	0	0	0	0
NH	30	0	0	0	0	0	0
SH	10	0	0	0	0	0	0
SH	20	0	0	0	0	0	0
SH	30	0	0	0	0	0	0
TV	10	0	0	1	0	0	6
TV	20	1	2	3	6	11	17
TV	30	1	3	4	6	17	22
SO	10	0	0	0	0	0	0
SO	20	0	0	0	0	0	0
SO	30	0	0	0	0	0	0
BO	10	0	0	0	0	0	0
BO	20	0	0	0	0	0	0
BO	30	0	0	0	0	0	0

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

Table 7. Percentage of non-zero counts expected from random observation points within the OTA adjusted for proportions of the 3 major habitats (tall-shrub/mixed-shrub, 48%, grass/exotic annuals, 33.8%, winterfat, 17.3%).

Species	Time	Percentage		
		<500m	<1000m	>1000m
ALL	10	27	48	59
ALL	20	40	65	76
ALL	30	43	69	80
RA	10	14	21	28
RA	20	16	29	40
RA	30	16	33	48
GE	10	3	12	15
GE	20	5	15	20
GE	30	5	17	26
PF	10	5	10	12
PF	20	9	20	22
PF	30	12	28	30
RT	10	3	5	6
RT	20	7	10	12
RT	30	10	14	16
FH	10	0	2	3
FH	20	2	5	6
FH	30	2	7	8
NH	10	3	6	6
NH	20	7	10	10
NH	30	7	13	13
SH	10	0	0	0
SH	20	0	0	0
SH	30	0	0	0
TV	10	0	0	1
TV	20	2	3	4
TV	30	2	4	5
SO	10	0	0	0
SO	20	2	2	2
SO	30	2	2	2
BO	10	1	1	1
BO	20	1	1	1
BO	30	1	1	1

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

Table 8. Percentage of non-zero counts expected from random observation points within the SRBOPA study area adjusted for proportions of the 3 major habitats (tall-shrub/mixed-shrub, 35.7%, grass/exotic annuals, 47.6%, winterfat, 9.8%).

Species	Time	Percentage		
		<500m	<1000m	>1000m
ALL	10	23	43	52
ALL	20	34	56	67
ALL	30	36	60	72
RA	10	12	19	25
RA	20	13	25	35
RA	30	13	28	42
GE	10	3	11	14
GE	20	5	14	19
GE	30	5	16	23
PF	10	4	8	10
PF	20	7	17	19
PF	30	10	24	27
RT	10	2	4	5
RT	20	5	8	9
RT	30	7	11	12
FH	10	0	2	3
FH	20	2	4	5
FH	30	3	6	8
NH	10	3	6	6
NH	20	6	10	10
NH	30	7	12	12
SH	10	0	0	0
SH	20	0	0	0
SH	30	0	0	0
TV	10	0	0	1
TV	20	1	2	2
TV	30	1	2	3
SO	10	1	1	1
SO	20	2	2	2
SO	30	2	2	2
BO	10	1	1	1
BO	20	1	1	1
BO	30	1	1	1

Species abbreviations:
RA = common raven *(Corvus corax)*, GE = golden eagle *(Aquila chrysaetos)*, PF = prairie falcon *(Falco mexicanus)*, RT = red-tailed hawk *(Buteo jamaicensis)*, FH = ferruginous hawk *(Buteo regalis)*, NH = northern harrier *(Circus cyaneus)*, SH = Swainson's hawk *(Buteo swainsoni)*, TV = turkey vulture *(Cathartes aura)*, SO = short-eared owl *(Asio flammeus)*, BO = burrowing owl *(Athene cunicularia)*.

seen. Interpretation can be done later when a sequence of actions leads to a known result, such as prey being caught, or when certain patterns under certain circumstances or in certain habitats are found to be unique and consistent. Most of the time behavior can be described by simple actions (Level 1, Table 2). Sometimes the behavior is too complex to describe this way, consisting of multiple actions occurring in too short a time-span. For these behaviors multiple action descriptions should be used (Level 2, Table 2). To assist interpretation of the behavioral action, the altitude of the bird should be recorded (Altitude, Table 2).

Flapping flight was the most commonly recorded behavioral action, with perching and soaring taking almost equal second place (Table 9a). Variations of soaring and flapping flight were the next most common actions, while gliding, hovering, and diving were rarely seen (Table 9a).

The majority of actions seen (flapping, soaring, perching), rarely gave any indication of the motive for the action (such as pursuit). Because raptors are opportunistic, we assumed that all flight actions were foraging (searching) behaviors, unless the flight involved either interacting with other animals (intra- and inter-specific maneuvers) or carrying prey. For the same reason, perching was considered foraging (searching) unless the bird was perched beside the nest. Any behavior sequence including hover and dive, or dive to ground, was considered to be pursuit. Thus, 5 behavior categories were used to summarize the actions recorded (Table 9b). Foraging was the most common behavior, with intra- and interspecific maneuvers and perched at the nest the next most common. Pursuit and carrying prey were rarely seen. The probability of sighting rare behaviors (<9% observations), increased as time increased, but remained low within the 30-min period (Table 9b), whereas the commonly observed foraging behaviors remained consistent at about 86% of observations.

Observer comparison

There was no significant difference in either the frequency of non-zero counts (Paired-t = 0.894, df = 8, $P > 0.05$) or the total number of birds counted (Paired-t = 1.17, df = 8, $P > 0.05$) between 2 observers working simultaneously but independently at the same observation site. There was no difference between observers in either the frequency of non-zero counts (Paired-t = 0.61, df = 9, $P > 0.05$), or total number of birds seen (Paired-t = 1.17, df = 9, $P > 0.05$) of each species at the 20-min time period and 1000-m sighting radius.

CONCLUSION

The need to identify raptor species limits the sighting radius to a maximum of 1000 m. The need for 50 to 75% non-zero counts limits the sighting radius to greater than 500 m, and time period to at least 20 min. The probability of seeing rare behaviors is increased only slightly by increasing the observation time period, so there is little, if anything, to be gained by observing for more than 20 min. About 50% of randomly chosen observation sites should have a visibility limit of >1500 m in all directions. Visibility limits at the remaining sites may be improved by moving the site by up to 400 m in 1 direction.

At a 20-min time period and 1000-m sighting radius there was no difference between observers in the number of non-zero counts, or total number of birds of each species seen. Although there were no detectable differences between observers, it would be advisable to alternate observers between on and off OTA observation sites and to test for differences between observers periodically during the study.

Table 9. a) Percentage of behavioral actions of all species observed within each 10-min interval up to 30 min. Where 2 actions are given, the first mentioned is the predominant action. b) Summary of behavior types identified among observed actions, following rules described in text. % = percentage of observations, C% = cumulative percentage of observations.

a) **Action**	10 min	20 min		30 min	
n	174	128	302	108	410
	%	%	C%	%	C%
Dive	0	0.8	0.3	0	0.2
Flap/Glide	2.3	0.8	1.7	1.9	1.7
Flap	45.4	59.4	51.3	46.3	50.0
Flap/soar	0.6	1.6	1.0	6.5	2.4
Glide/Flap	1.2	1.6	1.0	1.9	2.4
Glide	3.5	4.7	1.3	8.3	1.5
Glide/Soar	0	0	4.0	0.9	5.1
Hover/Flap	0	0.8	0.3	0	0.2
Hover	0	0	0	0.9	0.2
Perch	22.4	6.3	15.6	10.2	14.2
Soar/Flap	4.0	0.8	2.7	2.8	2.7
Soar/Glide	0.6	0.8	0.7	0	0.5
Soar	20.1	22.7	21.2	20.4	21.0
b) **Behavior**					
Maneuvers (social)	5.8	8.6	7.0	11.1	8.1
Pursuit	1.7	3.9	2.7	2.3	2.7
At nest	6.3	1.6	4.3	0	3.2
Carrying prey	0	0	0	0.9	0.2
Flight (Foraging)	86.2	85.9	86.1	85.2	85.9

Preliminary Evaluation of Proposed Techniques to Monitor Prairie Falcon Movements, Habitat Occupancy, and Food Delivery Rates to the Nest in Response to Military Training in the Orchard Training Area (OTA)

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Annual Summary

From April through July, a pilot study was conducted to develop and test methods of capturing, tagging, radio tracking, and monitoring of prairie falcons (Falco mexicanus). Twenty-two falcons were captured and banded; 18 were radioed. Between 20 May and 9 July, 333 individual location estimates of 13 falcons, 242 hrs of nest site observations, and 71 hrs of observation at military training sites were obtained. Statistical analyses of productivity data demonstrated no definitive differences between treatment and control birds. There was a trend towards lower numbers of fledglings/nest where birds were instrumented with backpack transmitters. Telemetry tests showed no difference in error estimates between antennae systems tested. No significant difference in rate of prey delivered to the nest on military training days (9.7 prey items/day) and control days (10.5 prey items/day) was found. There was no difference in the number of raptors observed in the OTA firing range on training or non-training days (1.98/hr vs. 2.04/hr). Some behavioral differences were noted. Results of this year's study were of a methods-evaluation nature rather than definitive analyses of data, primarily because of small sample sizes. Methods will be adapted for use in the long-term study.

OBJECTIVES:

1. Trap and radio mark 20 prairie falcons.
2. Test and evaluate a variety of radio-tracking methods.
3. Assess the effects of trapping, handling, and transmitters on prairie falcon productivity (in conjunction with Study 3).
4. Develop OTA firing range military and raptor monitoring protocols.
5. Determine the reliability of the written Idaho Army National Guard (IDARNG) training schedules.
6. Undertake prey delivery observations at the nest sites of radio-marked birds using the OTA.

7. Incorporate results from the 1990 pilot study to further develop the long term raptor study plan.

INTRODUCTION

Critical to the understanding of how prairie falcons react in the presence of military activity or any potential environmental perturbation is the development of a technique to accurately measure their behavior and movements. This is an extraordinarily difficult task because of the elusive and highly mobile nature of the prairie falcon. Although previous radio-telemetry studies have been conducted on prairie falcons, most of these efforts have been rather limited and no attempt has been made to measure the accuracy of the telemetry determined locations (e.g., Dunstan 1978, Harmata 1978, Haak 1982, Squires 1986). Furthermore, no alternative technique has shown any promise in providing relatively unbiased quantitative data on the activities and movements of prairie falcons. Here I describe and evaluate radiotelemetry and associated techniques proposed to enable us to determine whether differences exist between birds using the OTA and those that are not.

Studies undertaken in 1989 identified no satisfactory radio-tracking methods to decrease location errors over the distances required to triangulate across the OTA firing zone (Fuller et al. 1989). Field tests with 4-element Yagi antennae from a hand-held position and atop towers 3.05 m and 6.1 m in height resulted in large location errors (up to 5.83 degrees overall bearing error). Location estimate errors will affect home range data, habitat occupancy data, and interpretation of bird response to military training. Evaluation of radio-tracking methods and a thorough understanding of location estimate errors is therefore crucial (Lee et al. 1985, Laundre et al. 1987). By testing a variety of systems in 2 different areas I evaluated ways to enhance precision such that our data can be used to determine accurate estimates of prairie falcon home ranges and habitat occupancy.

Another facet of the pilot year study was to explore methods that will allow researchers to determine if military activities on the OTA affect the ability of raptors that use the OTA to obtain prey. As an index to foraging efficiency, field crews observed frequency of prey deliveries to the nest sites of birds that mostly foraged in the OTA. The key question is, does foraging efficiency differ with the presence or absence of military activity? Simultaneous tracking of these birds and monitoring of military activities were attempted to help interpret the influence of military training on the frequency of prey deliveries at nests.

To understand the effects of military training in the OTA on birds of prey, a method of observing and quantifying the type, timing, and intensity of various military activities and any corresponding behavioral changes in local birds was developed. Two approaches were employed this preliminary year: direct observation and examining military record keeping of training activities.

METHODS

Trapping, Banding, and Radio Tagging

Protocols for trapping and handling birds were developed in consultation with Bureau of Land Management (BLM) Birds of Prey biologists and other individuals who had experience working with falcons.

BLM biologists randomly selected control and treatment groups based on surveys of occupied prairie falcon nest sites in March.

Treatment groups consisted of nest sites where birds were to be fitted with backpack or tail-mounted radios. An additional category included eyries where trapping teams attempted to capture falcons but were unsuccessful. Trapping crews consisted of 2 climbers from the radiotelemetry study team and a BLM spotter whose job was to locate the nesting scrape. The spotter guided the climbers to the scrape via 2-way radio communication and monitored the behavior of the adult falcons.

One trapper rappelled down to the scrape, placed the eggs in an insulated box in a shaded area near the nest site, and substituted imitation eggs. Noose carpets were then secured to the substrate around the imitation eggs. If the trapping team determined that the setup presented undue danger to the birds the attempt was aborted.

Once the noose carpet was secured, the trapper departed and hid nearby. When the spotter reported the adult's return to the scrape, the trapper would "bump" the bird off the nest by clapping, waving, whistling, etc. If the adult was caught, the trapper quickly returned to the nest, disentangled the bird's feet from the nooses, and secured the bird (Bloom 1987). Falcons were then placed in a protective, padded bag and the traps reset. Trapping activities were terminated no later than 4 hrs after the adults were initially flushed from the eyrie.

After the young hatched and could thermoregulate (after 7 days of age), we attempted to capture additional birds in the vicinity of the eyrie using bal-chatri (Berger and Mueller 1959) baited with pigeons and dho-gaza (Bloom 1987) placed around a live great horned owl (*Bubo virginianus*) decoy.

All but 1 of the captured birds were banded with a USFWS band on the left leg and black alphanumeric color bands on the right leg. The placement of leg bands on the captured female at Spoon Upstream was reversed. Molt pattern, length and breadth of wing, sex, age class, general condition, mass, and crop content were recorded. These procedures usually required less than 15 min to perform by experienced personnel.

The initial long range study plans (see Fuller et al. 1990) involved instrumenting both adults at each eyrie. Our trapping crews attempted to capture both adults at each nest to determine the feasibility of this long range goal. Only 1 of the birds was to be radioed. The first bird caught was held until the second bird was caught or the 4-hr time limit expired. Procedures for retrieving and processing the second bird were the same as for the first except that the eggs were returned and trapping paraphernalia was removed by the trapper.

Nest sites were rejected when no birds were captured, no birds were found at a site, birds were not exhibiting nesting behaviors (i.e., no incubation), the spotter could not locate the nest site, or the trapping team determined the climbing conditions were unsafe. All rejected sites were replaced by other randomly-selected sites.

Male prairie falcons spend less time incubating than the females (Holthuijzen 1989), and are thus more difficult to capture when the birds are on eggs. Therefore, when both adults were trapped we instrumented the males.

Two types of transmitters were used: tail-mounted and backpack styles. I attempted to mount 10 transmitters of each type, 5 on males and 5 on females. Tail-mounted transmitters weighed about 9 g and were tied on the left or right side of the tail on the proximal end of rectrices no. 3 and no. 4. Knots were tied around the shafts of the feathers and glued. Backpack transmitters

were positioned as described in Snyder et al. (1989). Package weights of the backpacks units were approximately 15 g.

Follow-up productivity checks for number of young hatched and number of young fledged (reaching 30 days of age) were made by BLM personnel.

Radiotracking

The SRBOPA was divided into 3 zones: the OTA, west of the OTA, and east of the OTA. From 10-19 May Study 2 trackers using Advanced Telemetry Systems (Isanti, MN) receivers and handheld Yagi and/or H antennae scanned northward from the river into each zone to determine general use areas for individual birds.

Also during this period, receiver sites (high points with good road access) were identified and marked. Six semi-permanent antenna towers were built and placed on buttes on the perimeter of the OTA range road to take bearings across the inaccessible firing zone. At periodic intervals beacon radios were placed in known positions to assess bearing accuracy. From 4-6 June these receiver sites were surveyed in for us by IDARNG personnel using either the Positioning Azimuth Determining (PAD) system (See Army Technical Manual 5-6675-308-12) or conventional survey techniques. Precise receiver site locations were essential to minimize location errors.

Simultaneous bearings from at least 3 different receiver sites were attempted to determine location estimates on radio-marked birds. Whenever possible, 2 or 3 sequential locations of the same bird were taken at 10-min intervals.

From 20-31 May we intensively tracked 4 birds that primarily used the OTA for foraging. Radiotrackers were stationed around the OTA in positions to scan and detect when radiomarked birds came out of the canyon to forage. Once a signal was detected, bearings were taken at 10-min intervals until the signal was no longer heard. This tracking was done in conjunction with prey delivery observations and military activity monitoring. Because 2 of the 4 birds dropped their tail-mounted radios soon after the intensive tracking began, only the Fawn Draw and Sun Goddess birds were tracked for any length of time.

From 1 June to 9 July extensive tracking of radio-marked prairie falcons continued throughout the SRBOPA with primary focus on the area west of the OTA where the highest density of instrumented birds remained. Extensive tracking sessions involved searching for radio frequencies in a random sequence. Once a bird was detected, trackers attempted to triangulate on the bird's position. After 2 or 3 potential locations were obtained, scanning in random sequence was resumed.

From 19 July to 3 August beacon tests were conducted in the OTA across the firing zone and in the area west of the OTA. The purpose was to determine location and bearing errors of a null-peak antennae system both across the long distances and rolling terrain of the OTA and in the area west of the OTA where receiver sites were located closer together with less topographical relief.

For the OTA beacon test 20 radios were placed in pairs at benchmarks and previously surveyed points within the firing zone and at peripheral sites. Bearings were taken by 3 trackers from 5 receiver site locations adjacent to the range road. Two sets of bearings for the 2 different antennae systems (a 10-element Yagi on top of a 3.5-m tower and a null-peak system atop a 2.5-m tower) were taken. Scanning order for the

frequencies were randomized to prevent trackers from becoming familiar with the locations of specific radios. Trackers had no knowledge of the location of the beacons or that they were paired.

The beacon test west of the OTA was similar to the OTA test with paired beacons placed on benchmarks scattered throughout the zone. The null-peak system was tested along with a handheld 4-element Yagi. Two sets of bearings by 3 separate trackers were taken for each system from 6 different receiver sites.

For preliminary location analysis I used the telemetry program XYLOGAGZ.BAS developed at Northern Prairie Wildlife Research Center, Section of Upper Mississippi River Ecology, (La Crosse, WI) 54602. In addition to the program's criteria, I only accepted location estimates with an error ellipse size less than 800 ha.

Prey Delivery Observations

Eyries of radio-marked birds that spent much of their time in the OTA, as determined by preliminary radiotracking, and that offered an unobstructed view of the nest were selected for prey delivery observations. These data were collected in conjunction with observations of military activities and with intensive radio tracking of study birds in the OTA. Sampling periods consisted of an entire daylight period and were divided between days with military training and those with none.

Preliminary methodology followed that used by Holthjuizen (1989). Base camp and observation blinds were set up to ensure that nesting raptors would not be disturbed. Base camps could not be seen from the nest and were located at least 0.5 km from the nesting scrape. Blinds were placed at least 70 m away from the scrape.

Observations were conducted by 2 observers, each working a half day shift (approximately 8 hrs). Morning and afternoon shifts were alternated to eliminate observer bias.

Continuous observations were made using 15-60x spotting scopes and 10 x 50 binoculars. Male and female behaviors were recorded separately. Sex of the birds was easily determined because only 1 carried a radio package. The behavioral categories we used are listed in Table 1. Type, time, and duration of behaviors were recorded each min.

Prey deliveries were classified as bird, reptile, mammal, and uncertain. Whenever possible, Townsend's ground squirrels (*Spermophilus townsendii*) were specifically identified.

Military Activity and Raptor Behavior

Field technicians made direct observations of bird behavior during military activity at specific firing ranges and when no military activity was ongoing anywhere in the OTA. This involved developing a scanning technique, a behavioral catalogue, and testing procedures (Table 2).

Five behaviors were summarized to compare active training days to days with no military activity: number of birds Pursuing Prey (See Table 2), number of Kills (when Pursuing Prey resulted in a prey capture), number of birds Traveling Through the observation zone (combining Flapping and Gliding Flight in Table 2), Soaring, and Perching (same as in Table 2).

Observations were made from a high point or in a raised military observation post at the base of firing fans. Observation points were selected based on where the most intense military activity was scheduled and paired

Table 1. Prey Delivery Behavior Catalogue

DF = DISPLAY FLIGHT - rapid changes of altitude and flight pattern; in conjunction with other birds or alone.

AT = ATTACK - rapid swooping and following flight after another animal.

VO = VOCALIZATION - classified as to known individual or uncertain.

LV = LEAVE THE EYRIE - whenever the bird leaves the immediate vicinity of the eyrie.

RT = RETURN TO THE EYRIE - whenever the bird returns to the immediate vicinity of the eyrie.

(The above two categories are to ensure we know how much time the birds spend at and away from the eyrie.)

CO = COPULATION - male mounts female.

BR = BROODING - covering of the young by an adult bird.

IN = INCUBATION - covering of the eggs by an adult bird.

PE = PERCHING - remaining in one position for over 30 seconds while resting or preening.

PA = PATROLLING - alternately gliding and flapping in nesting territory in front of eyrie.

IV = IN VIEW - whenever a bird that has been missing returns into view; be sure to note where the bird is when you first see it (e.g., flying, at eyrie, perching in canyon).

OV = OUT OF VIEW - whenever a bird leaves your view for more than a few seconds; be sure to note where the bird was when you lost sight of it.

PD = PREY DELIVERY - whenever a bird is seen bringing prey into the nesting territory.

PX = PREY EXCHANGED - prey passed from one adult to the other.

PC = PREY CACHED - prey placed in the rocks within the nesting territory.

PR = PREY RETRIEVED - prey obtained from a cache.

FY = FEEDING YOUNG - prey being given to the young.

FS = FEEDING SELF - adult feeding on prey.

Table 2. OTA Raptor Behavior Catalogue

LEVEL 1: SIMPLE ACTIONS

FL - FLAPPING FLIGHT - flapping flight

GL - GLIDING FLIGHT - gliding flight, with loss of altitude

SO - SOAR - gliding in circles or a similar pattern with a gain in altitude

DV - DIVE - rapid loss of altitude (more rapid than a normal glide for the species)

HO - HOVER - flight with basically no ground speed

PE - PERCH - inactive or active, on the ground or an elevated position

LEVEL 2: COMPLEX ACTIONS

MA - MANEUVERS, INTRASPECIFIC - multiple, rapid changes of position and flying while interacting with the same species

ME - MANEUVERS, INTERSPECIFIC - multiple, rapid changes of position and flying while interacting with a different species

MI - MANEUVERS, INDIVIDUAL - multiple, rapid changes of position and flying while alone

FE - FEEDING - eating prey

CP - CARRYING PREY - flight with prey in talons

PP - PURSUING PREY- characteristic flight pattern for species when chasing down prey ending with a talon strike; for PF flight would be low level and rapid ending with a ground strike

Altitude of the bird at the time the action is performed may affect interpretation of the motive for the behavior and should be recorded.

ALTITUDE above ground during the observed behavior is recorded as follows:

Prefix:	Suffix:
FX - fixed altitude (no change)	1 - 0 to 10 meters
AS - ascending	2 - 10 to 30 meters
DE - descending	3 - over 30 meters

with a control day with no military training in the OTA. The observer continually made 360-degree scans until a raptor was detected within the firing range. The spotted bird was then monitored for 60 sec and its behavior recorded. The observer would then resume scanning at the point where the last bird was first seen. The types and length of observed military activities were also recorded (Table 3). The number of birds seen per hr and the behaviors of observed birds were then compared between active military training days and control days.

I also examined the official logs of military activities recorded during the periods when field observers monitored military training to compare IDARNG entries to our own monitoring data. The purpose of this comparison was to determine if it was possible to use IDARNG military records to relate military activities to movements of

Table 3. Military Activity Catalogue

0. CONTROL: NO ACTIVITY

1. TANKS
   - A) Preparation: Equipment or weapons on range setting up before activities begin
   - B) Moving
   - C) Moving and firing main turret gun (105 mm) or machine guns
   - D) Stationary and firing main turret gun (105 mm)
   - E) Stationary and firing machine guns
   - F) Idle: Between different activities, or a pause in activity

2. MACHINE GUNNERY
   - A) Preparation
   - B) Firing
   - C) Idle

3. HELICOPTERS
   - A) Preparation
   - B) Flying
   - C) Flying and firing
   - D) Idle

4. MORTAR FIRE
   - A) Preparation
   - B) Firing
   - C) Idle

5. TRAFFIC on RANGE ROAD
   - A) Convoys of wheeled vehicles (generally faster)
   - B) Convoys of track vehicles (slower)

instrumented birds if no research observer was present to monitor the area.

RESULTS AND DISCUSSION

Trapping, Banding, and Radio Tagging

Trapping teams attempted to capture falcons at 31 eyries between 16 April and 18 May. Thirteen nest sites were rejected: 8 because no birds were captured within the 4-hr time limit, 3 because there were no birds present, 1 because the birds present showed no signs of caring for eggs or young, and 1 because BLM biologists had climbed into the nesting scrape to count eggs as a control site (Table 4).

A total of 22 prairie falcons was captured and banded at 18 different nest locations. Nineteen were captured using noose carpets in scrapes. Bal-chatri and dho-gaza were used at 4 eyries from 28 May to 5 June. We captured 3 birds at 2 of these 4 nest sites using bal-chatri traps. Dho-gaza trapping was unsuccessful at the 2 nest sites where they were used.

Eighteen of the 22 captured birds were radio tagged. At 4 nest sites both the male and female were captured. Backpack transmitters were placed on 8 birds, 4 males and 4 females. Tail-mounted transmitters were placed on 10 birds, 5 males and 5 females.

Table 4. Prairie falcon nests selected randomly for treatment in 1990 that were rejected.

Nest	Date	Reason for Rejection
Red Trail	16 April	NC (4 hrs).
Corral Downstream	18 April	NC (4 hrs) 5 eggs.
Conning Tower	20 April	Designated a control nest.
Tom Draw	21 April	NBI (no eggs in nest).
Rosie Draw	21 April	NB.
Ogden Rock Downstream	21 April	NB.
Lower Priest	21 April	NC (3 hrs) bad weather.
Rock Island	26 April	NC (4 hrs) deep cave.
Dedication Point	27 April	NC (3.5 hrs) sunset.
Swan Dam Road Southside	28 April	4 hatchlings, 1 p egg.
	17 May	NC (2 hrs) bait, 4 young 3 weeks old.
Corral Blue Rock	2 May	pipped eggs.
	18 May	NC (4 hrs) bait, 4 young, 14-15 days.
Massacre Point	3 May	NB.
Cabin West	5 May	NC (3.5 hrs).

NB = No birds at scrape site.
NBI = No brooding or incubating.
NC = No capture.

Mean disturbance time (time from when the adult birds first flushed from the scrape until trappers departed from the area) was 3 hrs 12.9 min (SD = 47.1 min) and varied from 1 hr 14 min to 4 hrs 20 min (Appendix A).

Only 4 of the 22 captured birds had full or partially full crops. Mass of the 12 females ranged from 853 to 980 g with a mean of 912 g (SD = 42.8). Mean mass of the 10 males was 574 g (SD = 35.1) and ranged from 503 to 623 g. (Appendix A).

Molt information was recorded on 21 birds. No tail molt was observed, 3 showed no wing molt, in 17 birds both the left and right no. 4 wing primaries had molted and/or were at some stage of eruption, 7 were missing one or both no. 5 wing primaries, and 1 had loose no. 4 and no. 5 wing primaries on both wings. Overall, the sequence of molting for the capture period from 16 April to 17 May was no. 4 primary followed by no. 5 primary. This information supports Enderson (1964) who found remige molting began in early May, generally in the order 4-5-6-3-7-2-1-9-10.

Of the 10 birds tagged with tail-mounted transmitters, 7 lost their radios within 32 days: 1 in 3 days, 3 more within 2 weeks, 2 more by 3 weeks, 1 in 32 days. Only 3 tail-mounted radios remained on the birds as of 1 June. Radio signals were not detected for 2 of these transmitters after 1 June. One of these was later found south of the river. On the basis of tracking foraging movements and later visual verification, the remaining radio was still on the bird at the end of the tracking period (9 July). Three of the 6 radios that were recovered showed signs of biting by falcons (kinked antennae, ripped potting, etc.).

All 8 backpack radios remained on the birds and were functioning normally when each bird was last tracked. Three of the backpack-instrumented birds were last located on 26 June, 1 on 3 July, and the remaining 4 on 9 July, the last day of tracking. Robert Lehman, a BLM biologist, informed us that a technician saw a backpack radio dangling from the radiomarked Fever Basin Upstream female on 6 June. From 7-9 June spotters made repeated attempts to obtain visual verification of a loose transmitter. However, young from this bird's eyrie had already fledged, and we could not obtain a visual sighting. Based on daily radio tracking, this bird continued to forage actively in the area west of the OTA until 3 July. After that time its signal was no longer detected.

After the tracking season, field personnel periodically searched for the presence of any radioed birds. During the last half of August the signal quality and location of the backpack radio on the Crane Falls I bird did not vary. On 29 August I located the dropped radio at the base of the cliff just across the river from the original eyrie. The cotton threads holding the anterior end of the harness straps together had disconnected allowing the radio package to slip off the back of the bird as designed.

Five of the 8 nests attended by birds fitted with a backpack transmitter failed. Three of the 10 nests with birds fitted with a tail-mounted radio also were unsuccessful. One of the birds at these 3 nests dropped its radio within 2 weeks, 1 within 3 weeks, and the other still retained the radio well past the tracking period. Three of the 10 control nests (birds with no transmitters) failed, and 2 nests failed of the 8 where trapping was attempted but was unsuccessful. The mean number of young produced per nest were as follows: 1.9 for nests where backpack transmitters were used, 3.2 for nests where tail-mounted transmitters were used, 2.9 for control nests, and 2.0 where unsuccessful capture attempts were made. See Table 5 and Appendix B.

Table 5. Productivity of prairie falcons studied on the Snake River Birds of Prey Area in 1990.

Treatment Group	Number of Nests	Number of Failed Nests	Mean Fledged/Nest
Backpacks	8	5	1.9
Tailmounts	10	3	3.2
Not Captured	8	2	2.0[1]
Controls	10	3	2.9[2]
Radioed & Handled	18	8	2.6
Not Radioed or Handled	18	5	2.5[1,2]
Trapping Attempt	26	10	2.4[1]
No Trapping Attempt	10	3	2.9[2]

1 Corral Downstream was not included in the calculation of young fledged/nest because a complete count at fledging was not obtained.

2 **Editor's Note:** The 2 branching chicks at Rattlesnake Canyon were included in these calculations. BLM records classify this as an incomplete fledge count.

With such a small number of nests, teasing out the reasons for the differences in nest success and productivity was difficult. Failure rate was highest at nests being tended by birds carrying backpack radios, but the mean number of young produced at these sites was similar to nests where captures were attempted but were unsuccessful. This suggests that the radio harness in itself may not have had any adverse effect on nest productivity. Productivity was highest at nests where birds were trapped and instrumented with tail-mounted radios.

I also compared nests where birds were handled and instrumented (n = 18) to those where neither action took place (n = 18). The former group had a higher percentage of failures (44% vs. 28%) but also produced slightly more fledglings per nest (2.6 vs. 2.5).

A third comparison was made between nests where trapping was attempted (n = 26) and control sites (n = 10). Nest failures were 38% and 33% respectively. The number of fledglings per nest for trapped sites was 2.4 and 2.9 for controls (Table 5).

Chi-square, Mann-Whitney U tests, and Kruskal-Wallis one-way analysis of variance were done on the above 3 comparisons to determine if differences were significant between groups for failure rates and for numbers of young fledged. No statistically significant differences were found ($P > 0.05$). This is not surprising considering the small sample size. Despite the lack of statistical significance I am concerned with the relatively high failure rate of backpack-radioed birds and will make all attempts to eliminate any adverse instrumentation effects on the birds.

Radiotracking

During the intensive and extensive tracking of prairie falcons 980 bearings were taken on 13 birds. Five of the birds were never located because their tail-mounted radios were dropped before tracking began. A total of 333 triangulations was attempted: 116 based on 2 bearings, 170 with 3, 43 with 4, and 4 with 5 bearings. An average of 25.6 (SD = 36.5) triangulations per bird were attempted (range = 1 to 128).

In the area west of the OTA 133 locations of study birds were attempted. The XYLOGAGZ.BAS program solved 59 (44.3%) of these within the 800-ha confidence ellipse limit. Mean angular error for the solved locations was 3.1 degrees (SD = 2.1). Mean size for the 95% confidence ellipses was 222.6 ha (SD = 231.5).

In the OTA we attempted 200 locations on the 4 instrumented birds using the area: 93 with 2 bearings and 107 with 3 bearings. Most of these locations were during the early intensive periods when we tried to locate each bird every 10 min during tracking sessions. Of the attempted locations 37.5% were solved within the 800-ha limit. This percentage was lower than the 44.3 % in the area west of the OTA. In part this is probably due to the increased difficulty of locating birds inside the range road on the OTA where the terrain has more relief and the distances to the birds from the receiver sites were the greatest. Still, at least 1 or 2 usable locations were determined each day (sometimes up to 13 a day) for each radio-instrumented bird using the OTA. The mean error ellipse size for bird locations in the OTA was 223.3 ha (SD = 211.3) and the mean angular error was 3.5 degrees (SD = 2.9).

There was no difference between real bird location estimates in the area west of the OTA and real bird location estimates in the OTA with regard to bearing error or error ellipse size (for bearing error: $\underline{t} = 1.06$, df = 132, $\underline{P} = 0.29$; for error ellipse size: $\underline{t} = 0.02$, df = 132, $\underline{P} = 0.99$).

Data from the beacon test in the west study area showed no significant difference in bearing error or confidence ellipse size between the null-peak and the handheld Yagi antennae (for bearing error; $\underline{t} = 0.7$, df = 61, $\underline{P} = 0.48$; for 95% confidence ellipse size; $\underline{t} = 0.29$, df = 61, $\underline{P} = 0.77$). For both antennae systems combined the mean angular error was 4.2 degrees (SD = 2.2) and mean 95% confidence ellipse size was 128.6 ha (SD = 140.7). Past studies have shown null-peak systems reduce error considerably (Pace 1988). However, this system is more expensive, needs daily fine tuning, and is difficult to transport. Since I found no significant error reduction by using the null-peak antennae system, the 4-element handheld Yagi was selected as the primary antenna system for future work.

Data from the beacon test in the OTA indicated no difference in bearing error or confidence ellipse size between the null-peak and tower-mounted Yagi antennae systems (for bearing error: $\underline{t} = 0.61$, df = 54, $\underline{P} = 0.54$; for error ellipse size: $\underline{t} = 1.13$, df = 54, $\underline{P} = 0.26$). The mean bearing error for the combined data was 3.1 degrees (SD = 1.7). The mean combined error ellipse size was 235.8 ha (SD = 236.6).

We found no difference in bearing error or confidence ellipse size between the location estimates of real bird and placed radio beacons in the OTA (for bearing error: $\underline{t} = -1.01$, df = 129, $\underline{P} = 0.32$; for error ellipse size: $\underline{t} = 0.32$, df = 129, $\underline{P} = 0.75$).

In the area west of the OTA there was a significant difference in both bearing error and confidence ellipse size for location

estimates of real birds and beacons (bearing error: $t = 3.09$, df = 120, $P = 0.002$; error ellipse size: $t = -2.73$, df = 120, $P = 0.007$).

The reason that the location error ellipse size was significantly less for beacons in the area west of the OTA may be related to better line-of-sight radio reception in that area. In this study area, receiver sites were elevated over fairly flat terrain. Thus, very little bounce or signal distortion occurred on stationary beacon radios. With real birds signal modulation probably occurred as they moved across the terrain causing a greater location error. In the OTA there was more potential for signal interference for both beacon and real bird radios from the more rolling topography and military related radio transmissions.

The data from this year's pilot studies and beacon tests indicate that actual bird location estimates can be made with enough precision to be useful for home range and habitat occurrence analysis. Use of laptop computers in the field with state-of-the-art triangulation solution software to check on the location error and accuracy of bearings will be essential to insure enough data can be obtained to answer the long-term study questions.

Prey Delivery Observations

Three nests were observed for 241.7 hrs from 19 May to 1 June 1990. This period coincided with the brood-rearing phase when both adults were providing food for young. Only 1 nest (Fawn Draw) was extensively watched (206.6 hrs) because the tail-mount radios on the birds at the other 2 sample sites were dropped soon after the observation periods began.

Nine complete daylength periods of observation were made (7 for Fawn Draw, 2 for Tick II). Four and 6 prey were delivered, respectively, during the 2 days the Tick II site was watched. At Fawn Draw the number of deliveries varied from 7 to 14 per day with a mean of 10.1 (SD = 2.7).

Of the 7 complete days of observation at the Fawn Draw eyrie 3 were active military training days and 4 were control days with no training. A mean of 10.5 (SD = 3.1) prey deliveries per day occurred on control days. On training days the mean number of prey deliveries per day was 9.7 (SD = 2.5). There was no difference between numbers of prey delivered on military activity and control days (Mann-Whitney U test statistic = 7.0, df = 1, $P = 0.72$).

A total of 111 prey deliveries was observed. At Tick II all 10 prey deliveries were Townsend's ground squirrels. At Rosie Upstream South all 3 prey deliveries were Townsend's ground squirrels. Of the 98 prey deliveries observed at Fawn Draw, 42 were birds (40 of which were delivered by the male), 29 were mammals (17 of which were identified as Townsend's ground squirrels), 1 reptile, and 26 unidentified prey items.

At the Fawn Draw eyrie a third adult (a second male based on size) was observed delivering food to the young on 7 different occasions. The second male was distinguished from the first male because it was marked with a different colored legband. Only once did the second male exchange its prey with the nest female. All other prey deliveries were quickly dropped on the eyrie, and the bird departed.

Military Activity and Raptor Behavior

A total of 70.9 hrs of bird behavior observation was made during an intensive 2-week study period; 42 hrs during 7 control days with no military activities and 28.9 hrs of during 4 days of military activity. Originally, I scheduled observations during 6

control and 6 military activity days. I was not notified that 2 days of military training were canceled. One of these days was used as an additional control day, and the second was dropped. Behavioral data taken on a pair of northern harriers and a pair of short eared owls that resided on the edge of one of the firing ranges were deleted for comparison purposes. Their repeated presence in the behavioral data at only 1 firing range site would have artificially inflated the average number of behaviors per hr.

Behaviors were compared between training and non-training periods (Table 6). Eighty-three birds were seen during the control days (1.98 birds observed/hr). Fifty-nine birds were spotted during the military activity days (2.04 birds/hr). There was no difference in the number of birds detected on military activity and control days (Chi-square = 0.037, df = 1, $P = 0.85$). More Prey Pursuits were successful (ended in a Kill) during control days than training days (25.9% vs. 4.2%), and there were more birds Traveling Through the area (Flapping and Gliding Flight) during non-training days (39% vs. 9%). Birds were observed Soaring in the area a greater percentage of the time during military training days as compared to control days (41% vs. 24% ; Table 2). A larger sample is needed before making any conclusions.

Severe weather may have confounded results during this brief intensive study period. During the beginning of the study period the days were cold and rainy, reducing activity and visibility. Most of these days were control days. This could have potentially hidden any real differences between the behaviors and number of birds that were observed. Increasing the number of observation days and only observing during certain weather conditions will eliminate this bias in the future.

The IDARNG kept 2 forms of records of training activity for the OTA. First, there was the . Range Management Input

Table 6. Summary of raptor behavior observations in the presence and absence of military activity on the Orchard Training Area.

	MILITARY ACTIVITY	
	ABSENT	PRESENT
Total number of raptors observed	83	59
Total number of hours observed	42.0	28.9
Number of raptors per hour	1.98	2.04
Numbers (percentage) of raptors observed:		
PURSUING PREY	27 (33%)	24 (41%)
KILLS	7 (8%)	1 (2%)
TRAVELING THROUGH AREA	32 (39%)	9 (15%)
PERCHING	6 (7%)	1 (2%)
SOARING	11 (13%)	24 (41%)

Worksheets used to summarize overall daily activity of a particular military unit. These were primarily inventories of personnel, vehicles, aircraft, and ammunition used and of limited use in delineating specific activities and their duration. These records did indicate which days firing took place and what sort of equipment was used.

The second source of information we examined was the Cinder Cone log book. This was a register of all communications made with the range control center. Military operators recorded when a range was considered "hot" and when it became "cold." These designations defined when an area was closed to other use, not when actual firing took place.

These records could be used to provide crude indexes of the level of military activity such as on which days there was firing or maneuvers. Little information is provided on timing and duration of specific training activities. For any detailed information on actual firing times and specific locations we need to maintain our own observers.

RECOMMENDATIONS

Based on 1990 results I make the following preliminary recommendations:

1. Trapping should be terminated after the first bird is captured or after 2 hrs of disturbance, which ever comes first.

2. Transmitter weight should be reduced as much as possible and configuration should be streamlined.

3. Radio-mounting procedures should be refined to minimize irritation to the birds.

4. Trapping should not be attempted at any site during inclement weather.

5. Trapping should not be attempted at eyries where direct sunlight may fall on the eggs for several hours after capturing the adult.

6. Trapping along the canyon rim before the birds begin to nest should be attempted.

7. Intense follow-up observations should be made immediately on all instrumented birds.

ACKNOWLEDGMENTS

Thanks go to the entire Greenfalk staff for their invaluable assistance with data gathering, analysis, and editorial assistance especially Dr. Jim Bednarz, Frank Lapsansky, and Kathy Maechtle.

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Appendix A. Results of 1990 prairie falcon trapping and tagging.

DATE	LOCATION	USFWS BAND NO.	COLOR BAND COLOR	LEG	CODE	DISTURB TIME	SEX	MASS (g)	% CROP	WING SPAN	WING WIDTH	TREATMENT T/B/N	TREATMENT FREQ	# EGG/YOUNG
16 Apr	Spoon Upstream	816-70242	BL	L	N/U	2H, 0M	M	573	26-50	870	155	B	5.005	1/4
17 Apr	Sand Rock	1807-01201	BL	R	V/P	3H, 17M	F	915	0-25	347(C)	347	T	5.041	5/0
18 Apr	Shoofly	1807-01211	BL	R	V/A	3H, 57M	F	918	0-25	1020	185	T	5.337	5/0
19 Apr	Fawn Draw	1807-01202	BL	R	V/R	2H, 30M	F	868	0-25	336(C)	195	B	5.728	5/0
19 Apr	Powerline	1807-01203	BL	R	V/S	3H, 58M	F	923	51-75	344(C)	195	T	5.175	4/0
20 Apr	Cuffy Fingers	816-70243	BL	R	N/R	3H, 44M	M	553	0-25	920	150	B	5.295	5/0
20 Apr	Fewer Basin Upstream	1807-01204	BL	R	V/T	3H, 30M	F	913	0-25	351(C)	186	B	5.093	5/0
21 Apr	Rosie Upriver South	816-70244	BL	R	N/E	3H, 10M	M	593	0-25	964	185	T	4.965	5/0
21 Apr	Bruneau Flats	1807-01213	BL	R	V/C	1H, 14M	F	980	0-25	1080	185	B	4.076	5/0
21 Apr	Strike Island	1807-01212	BL	R	V/B	2H, 50M	F	953	0-25	990	180	N		5/0
21 Apr	Strike Island	816-70245	BL	R	N/C	2H, 50M	M	583	0-25	950	140	T	5.054	5/0
26 Apr	Sun Goddess	1807-01205	BL	R	V/N	4H, 6M	F	903	0-25	1064	180	N		2/0
26 Apr	Sun Goddess	816-70246	BL	R	N/G	4H, 6M	M	553	0-25	890	160	B	5.393	2/0
27 Apr	Dedication Site	1807-01206	BL	R	V/M	4H, 5M	F	973	0-25	1170	182	T	5.375	5/0
30 Apr	Narrows	816-70150	B	L	I/V	2H, 57M	M	623	0-25	972	153	T	4.925	5/0
30 Apr	Narrows	1807-01207	BL	R	V/K	2H, 57M	F	853	0-25	1064	183	N		5/0
1 May	Mother Giant Dike	1807-01208	BL	R	V/D	3H, 30M	F	893	0-25	1044	170	B	5.115	4/0
3 May	Cattleguard Gate	816-70247	BL	R	N/A	4H, 20M	M	593	0-25	954	149	T	5.313	5/0
4 May	Crane Falls I	816-70248	BL	R	N/B	2H, 0M	M	613	26-50	950	159	B	5.015	5/0
17 May	Point	816-70249	BL	R	N/M	3H, 15M	M	503	0-25	928	140	T	4.882	0/5
17 May	Point	1807-01209	BL	R	V/G	3H, 15M	F	853	0-25	1142	172	N		0/5
18 May	Tick II	816-70156	B	L	Z/H	?	M	563	76-100	—	—	T	5.138	0/5

HEADER EXPLANATIONS:

COLOR BAND
COLOR: BL = black, B = blue (recapture, banded 1987)
LEG: L = banded left leg, R = Banded Right leg
CODE: letter code written on band, vertical orientation

DISTURB TIME: Time from when the adult birds were initially flushed to when the trapping team left the area

WING SPAN (C): Wing cord taken.

TREATMENT GROUP:
T = bird instrumented with tail-mount radio, B = bird instrumanted with back-pack mounted radio, N = bird not radioed, FREQ = frequency in 164 or 165 khz range

EGGS/YOUNG: number of eggs in nest at initial climb/ number of young in nest at initial climb

Appendix B. 1990 Prairie Falcon Productivity.

NEST NAME	TREATMENT[1]		EGGS		FLEDGLINGS		COMMENTS
	B/T/C	M/F	#	DATE[2]	#	DATE[2]	
Guffey Fingers	B	M	5	02 Apr	0	02 Jun	Failed
Fever Basin Upstream	B	F	5	20 Apr	5	01 Jun	
Spoon Upstream	B	M	1*	16 Apr	0	15 May	Failed
Fawn Draw	B	F	5	19 Apr	5	06 Jun	
Bruneau Flats	B	F	5	21 Apr	0	19 May	Failed
Sun Goddess	B	M	2	26 Apr	0	23 May	Failed
Mother Giant Dike	B	F	4*	01 May	5	08 Jun	
Crane Falls I	B	M	5	04 May	0	23 May	Failed
Dedication Site	T	F	5	27 Apr	0	18 May	Failed
Rosie Upriver South	T	M	5	21 Apr	4	11 Jun	
Powerline	T	F	4	19 Apr	0	14 May	Failed
Sand Rock	T	F	5	17 Apr	5	27 May	
Shoofly	T	F	5	18 Apr	4	28 May	
Strike Island	T	M	5	21 Apr	4	31 May	
Cattleguard Gate	T	M	5	03 May	5	10 Jun	
Tick II	T	M			5	30 May	
Narrows	T	M	5	30 Apr	5	15 Jun	
Point	T	M	5	04 May	0	06 Jun	Failed
Conning Tower	C		2	18 Apr	0	16 May	Failed
Wildhorse SW	C		5	19 Apr	0	04 Jun	Failed
Mac the Knife	C		5	17 Apr	5	28 May	
Jackass Butte	C		5	19 Apr	5	11 Jun	
Rattlesnake Canyon	C		4	17 Apr			
			1*	23 May	2**	21 Jun	
Rattlesnake Narrows	C		1*	14 May	4	04 Jun	
Camera	C				5	30 May	
Balls Basin Hamer	C				4	31 May	
Powerline Mirror	C		1*	01 May	4	31 May	
Below Road	C		5	01 May			
			4*	23 May	0	21 Jun	Failed
Corral Downstream	NC		5	18 Apr	3**	23 May	Incomplete Fledge Count
Rock Island	NC		4	26 Apr	4	04 Jun	Young Not Banded
Priest Lower	NC		2	21 Apr	2	03 Jun	
Dedication Point	NC		4	27 Apr	0	18 May	Failed
Red Trail	NC		5	16 Apr	2	30 May	
Corral Blue Rock	NC		?	02 May	2	03 Jun	
Swan Dam Road South Side	NC		1*	28 Apr	4	30 May	
Cabin West	NC		5	05 May	0	10 Jun	Failed

1 B = backpack radio; T = tail mounted radio; C = control (no radio). M = male; F = female.

2 Dates shown are the dates that nests were checked, not the actual date of laying, hatching or fledging. Numbers shown are numbers found on these dates.

* Incomplete clutch counts.

** Editor's Note: BLM records classify as incomplete fledge counts.

Habitat Classification and the Ability of Habitats to Support Townsend's Ground Squirrel and Black-tailed Jackrabbit Populations

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Annual Summary

Indexes of Townsend's ground squirrel (Spermophilus townsendii) populations averaged 49.2 total burrows/ha (13.6 active; 35.6 inactive) for 44 sites randomly selected throughout the Integration Study Area, located within the Snake River Birds of Prey Area (SRBOPA), and Orchard Training Area (OTA). We counted 104.9 burrows/ha (29.7 active; 75.2 inactive) for 53 traditional transects in the SRBOPA. Observer bias on strip transects to count burrows of Townsend's ground squirrels influenced the classification of active vs. inactive burrows and the estimate of total burrow numbers. The coefficient of variation ranged from 0-8.4% of the estimated N on 10 transects tested for observer bias using the 2-sample capture-recapture (Peterson) estimator. Estimates of black-tailed jackrabbit (Lepus californicus) densities along spotlight transect routes were estimated at 0.30/ha (0.28-0.32, 95% C.I.) for all habitats and 0.50/ha (0.27-0.73, 95% C.I.) in sagebrush (Artemisia sp.) communities. We also observed 50 Nuttall's cottontail rabbits (Sylvilagus nuttallii), 4 pygmy rabbits (Brachylagus idahoensis), 1,256 kangaroo rats (Dipodomys ordii and D. microps), and 146 mice and voles (including Lagurus curtatus, Microtus sp., Onychomys leucogaster, Perognathus parvus, Peromyscus maniculatus, and Reithrodontomys megalotis) on spotlight transects.

OBJECTIVES:

1. To assess influence of military activities, livestock use, and wildfires on habitats, Townsend's ground squirrels and black-tailed jackrabbit abundance.

2. To determine habitat correlates of Townsend's ground squirrel and abundance and establish permanent transects that will be resampled at specified intervals for long-term monitoring of vegetation and Townsend's ground squirrels.

3. To continue monitoring the relative abundance of Townsend's ground squirrels on transects established in 1982 within the Snake River Birds of Prey Area.

4. To determine the bias associated with observer ability to detect burrows of Townsend's ground squirrels during strip censuses on the Snake River Birds of Prey Area.

5. To estimate jackrabbit densities for all habitats grouped and for

sagebrush communities from night spotlight counts along previously established transects.

6. To record all sightings of Nuttall's cottontail rabbits, pygmy rabbits, kangaroo rats, and mice and voles (combined) on spotlight transects.

METHODS

Townsend's Ground Squirrels and Habitats

Selection of Random Sampling Locations.--Study 5 of the Bureau of Land Management/Idaho Army National Guard (BLM/IDARNG) Research Project sampled habitats and prey within the Integration Study Area of the Snake River Birds of Prey Area. Forty-four sites north of the Snake River were randomly selected according to 2 strata. First, the number of sites was apportioned relative to the respective areas(ha) of the Integration Study Area of the SRBOPA and the OTA. Second, number of sites within the Integration Study Area or the OTA was proportional to the area (ha) of the habitats determined from satellite imagery (Tables 1 and 2). All sites were marked in the field by metal fence posts for future studies of long-term changes (e.g., Anderson and Holte 1981, Turner 1990) with the exception of sites located within the OTA Impact Area that were not marked in 1990 because of safety concerns.

Table 1. Area (ha) and percent of habitat types classified by the GIS for the Integration Study Area and OTA with number of transects completed in 1990. Integration Study Area total does not include the OTA area. Habitats are described in Table 2. Number of plots assumes minimum of 5 per category and approximately 1,000 lots for total sample effort. Percent totals are <100% because of unused categories (water, urban, wetland).

Habitat Type	OTA				Integration Study Area			
	Area (ha)	%	Plots	1990	Area (ha)	%	Plots	1990
Tall Shrub	23,663	42.1	164	9	16,822	17.6	111	5
Mixed Shrub	884	1.6	6	2	4,758	5.0	31	1
CELA	2,736	4.9	19	1	3,171	3.3	21	1
ATCO	2,468	4.4	17	2	5,481	5.7	36	3
CELA/ATCO	6,969	12.4	48	2	1,984	2.1	13	
Grass/EXAN	19,012	33.8	132	7	53,222	55.7	351	10
Agriculture	14	0.0	5		2,768	2.9	18	
Fallow	21	0.0	5		5,144	5.4	34	1
Bare Ground	289	0.5	5		537	0.6	5	
Total			401	23			620	21

ATCO = shadscale, CELA = winterfat, EXAN = exotic annual

Table 2. Habitats in the Snake River Birds of Prey Area that were classified by satellite imagery for use in classification of polygons for the Digitized Resource Data Base Map.

Habitat	Characteristics
1. Tall Shrub	>10% Big sagebrush, greasewood, or rabbitbrush
2. Tall shrub/Winterfat/ Shadscale	>10% tall shrub, with >10% winterfat or shadscale
3. Winterfat	>10% winterfat
4. Shadscale	>10% shadscale including Nuttall's saltbush
5. Winterfat/Shadscale	>10% winterfat and shadscale
6. Grass/Annual Weed	>10% annual or perennial; <10% shrub includes seedings
7. Agriculture	current cultivation or irrigation
8. Fallow Agriculture	bare agricultural land
9. Wetland	marsh and riparian
10. Urban/Unclassified	towns
11. Bare Ground	<10% of total cover
12. Water	open body of water

Vegetation.--The sampling site was a 5 x 400-m strip transect for counting burrows of ground squirrels, with $\geq$4 50-m transects perpendicular to the center line for vegetation, soils, and military and grazing information (Fig. 1). At least one 50-m transect was randomly located within each 100-m segment (Fig. 1). Therefore, each site effectively sampled a 100 x 400-m area (4 ha).

We sampled vegetation (species composition, frequency, canopy cover, % bare ground) by point intercept (Floyd and Anderson 1982) from one 5-m section at randomly-determined points on each 50-m transect (Fig. 1). The sample unit consisted of one 5-m section. The number of transects with single 5-m sections needed to determine vegetation characteristics was assessed in the field by calculating a running mean of the 4 most abundant categories (Grieg-Smith 1983) and ranged from 4-7 sample units. Additional transects needed to obtain a stabilized mean were added at randomly-selected points along the entire 00-

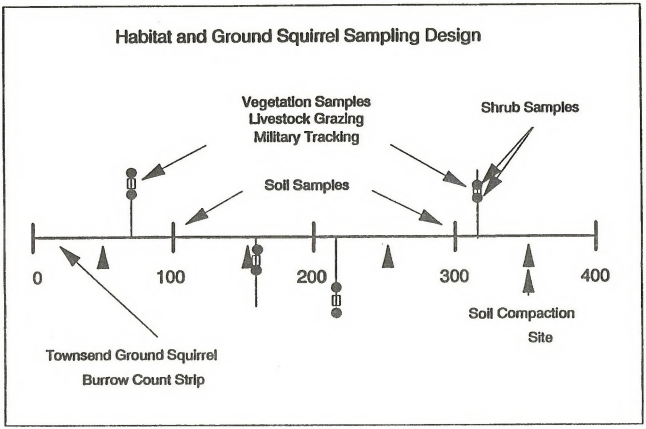

Fig. 1. Design for sampling habitat and Townsend's ground squirrel burrows at randomly selected sites.

m burrow count transect. Each 100-m segment of the burrow count strip had ≥1 perpendicular transect for vegetation sampling.

When shrubs were present, shrub density, mean shrub height, mean shrub height from ground to canopy, and presence/absence of canopy was determined from 20-m^2 (2.52-m radius) plots (Asherin 1973). Number of shrubs needed for sampling was calculated from a running mean. Shrub plots were established at each end of the 5-m sections for vegetation sampling by point frame (Fig. 1).

Number of species present (S, species richness) and species diversity (H, species evenness) were determined for total species composition at a sampling site. The diversity index was $H = 1/\Sigma p_i^2$ where p_i was the proportion of the ith species in the total sample (N_i/N) (Hill 1973, May 1981). This index equaled 1 when a single species dominated the sample; higher values resulted from number of species and evenness of distribution.

Soils.--Soil samples were collected at the 100 and 300-m points along the burrow count transect (Fig. 1). At each point, we collected samples from the surface and at a 1-m depth to determine soil texture. We determined soil compaction with a Lang soil penetrometer at 20-m intervals along the burrow count transect (Lang Co., Gulf Shores, AL).

Military Use.--Tracking intensity was determined by categorical estimation (presence = 1; absence = 0) of military tracks along each 100-m segment of the 5-m wide transect line. Influence of military tracking on number of burrows was compared between the randomly-selected sites for sites with presence of tracks to sites without tracks by Student's t-test (PROC TTEST, SAS Statistical Inst. 1988). Samples were grouped for all habitats within each category (presence/absence) because of limited samples within each habitat type.

Livestock Use.--Livestock grazing was treated as a nonmanipulated variable for comparison with counts of ground squirrel burrows. At each burrow count transect, a categorical estimate (presence = 1; absence = 0) of cattle and sheep use was obtained along each 100-m segment (Fig. 1) from presence of fecal material, or tracks. In addition, relation of sampling site to the drift fence and season of grazing were obtained from the GIS system for comparison with burrow counts.

Relationship of livestock presence on number of burrows was compared between randomly-selected sites with presence of livestock (tracks or fecal material along the transect) to sites without livestock presence by Student's t-test (PROC TTEST, SAS Statistical Inst. 1988). Because of limited sample size, samples were grouped for habitats for each category (presence/absence) within each habitat type.

Townsend's Ground Squirrels.--Numbers of Townsend's ground squirrel burrows were counted in 5 x 400-m transects at the end of the active season for squirrels from 11 June through 26 July. An observer recorded all active and inactive ground squirrel and badger (*Taxidea taxus*) burrows in the strip. Criteria to distinguish active burrows from inactive included absence of wind-blown debris or spider webs, presence of claw marks or feces at the burrow, presence of trails emanating from the burrow, observation of squirrels, or absence of plant roots from burrow ceiling (Peterson and Yensen 1986, Wheeler et al. 1989).

Yearly sampling also was continued on 53 of 54 previously established 400 x 5-m strip transects (excluding 16 transects established to monitor effects of burns in shadscale (*Atriplex confertifolia)* habitats [Groves and Steenhof 1988] and 11 in

seeded areas) to permit calibration and reference to previous research. We were unable to locate 1 traditional transect.

Statistical Analysis of Ground Squirrels and Habitats.--Relationships between numbers of ground squirrel burrows and all environmental variables, including east and north UTM coordinates, and presence of livestock or military, was first tested by linear regression (PROC REG, SAS Statistical Inst. 1988). Habitat associations were also determined by ordination of environmental variation with detrended correspondence analysis (CANOCO, ter Braak 1988) and subsequent regression of burrow numbers against the first 2 ordination axes (ter Braak and Prentice 1988).

Observer Bias in Burrow Counts on Strip Censuses.--Potential influence of observer bias was tested at 10 transects. Hole counts along transects were independently conducted by 2 teams of 2 observers. Rotation of starting group was randomly determined. The center line was delineated by a tape with consecutive 5-m segments identified. Each observer group mapped the location of all burrows within each 5 x 5-m segment along the strip. Observer bias was the deviation from the $\underline{N}$ determined from the 2-sample capture-recapture (Petersen) estimator (Seber 1982:59). This method assumed that (1) sightings were independent between different objects and different teams, (2) the probability of sightings was the same for each team but can vary between teams, (3) mapping was precise so that each sighting was attributed to each team, and (4) the population was constant in size. Estimates of total burrow numbers were determined by

$$\underline{N} = \frac{(\underline{n}_1 + 1)(\underline{n}_2 + 1)}{(\underline{n}_{1,2} + 1)} - 1$$

where $\underline{N}$ was the population size estimate, $\underline{n}_1$ was the number seen by the 1st team, $\underline{n}_2$ the number seen by the 2nd team, and $\underline{n}_{1,2}$ was the number seen by both teams (Pollock and Kendall 1987). The variance of $\underline{N}$ was estimated by

$$V(\underline{N}) = \frac{(\underline{n}_1 + 1)(\underline{n}_2 + 1)(\underline{n}_1 - \underline{n}_{1,2})(\underline{n}_2 - \underline{n}_{1,2})}{(\underline{n}_{1,2} + 1)^2(\underline{n}_{1,2} + 2)}$$

(Seber 1982:60).

Jackrabbits

Jackrabbits were counted by spotlight at night between 2200 and 0500 hr (Smith and Nydegger 1985) from 21 May to 6 June by driving along previously established transects (Doremus et al. 1989). Each transect was driven 3 times on separate nights. Transects in the OTA were run on 3 consecutive nights. Sightings of kangaroo rats, Nuttall's cottontail rabbits, pygmy rabbits, and mice and voles were recorded on black-tailed jackrabbit spotlight transects.

Density of jackrabbits was estimated using program TRANSECT (Burnham et al. 1980). Previously, density was estimated by the exponential power series estimator for each year except for 1980 (Doremus et al. 1989). I reanalyzed the results from 1977 through 1990 and used the density estimator with the best fit to the data and the lowest percent confidence interval. The exponential power series estimator was used in all years except for 1980 through 1982 when the negative exponential estimator provided the best fit, and for 1990 sagebrush data when the exponential polynomial was used.

Habitat types were determined by ocular estimate along transect routes (Table 3). Total distance for each habitat type was the accumulated odometer reading along all routes. Sightings of all species were grouped into habitat types. Presentation of jackrabbit results for all habitats grouped and separately for sagebrush communities was based on previous convention.

RESULTS

Townsend's Ground Squirrels and Habitats

We sampled 21 sites outside of the OTA within the Integration Study Area and 23 in the OTA for Townsend's ground squirrels and habitat (Table 1). In addition, burrows were counted on 53 of 54 traditional transects in the SRBOPA. We were unable to locate 1 traditional transect. Indexes of Townsend's ground squirrels averaged 49.2 total burrows/ha (13.6 active; 35.6 inactive) for 44 sites randomly selected throughout the Integration Study Area and OTA (Table 4) and 104.9 burrows/ha (29.7 active; 75.2 inactive) for 53 traditional transects (Table 5).

Plant species richness, S, ranged from 1 to 9 for the randomly-selected sites and

Table 3. Distribution of habitats sampled (total km) for the black-tailed jackrabbit transects in 1990. Distances were determined from odometer totals in each habitat.

Habitat Type	Distance (km)
Sagebrush	217.92
Sagebrush/Winterfat	38.58
Winterfat/Grass	25.83
Winterfat	4.80
Shadscale	60.63
Shadscale/Winterfat	25.98
Sagebrush/Rabbitbrush	0.66
Crested Wheatgrass	40.95
Grass	127.50
Rabbitbrush	4.62
Sagebrush/Shadscale	22.65
Greasewood/Shadscale	9.06
Greasewood/Sagebrush	0.00
Greasewood	18.30
Nuttall's Saltbush	0.78
Riparian	0.00
Canyon shrubs	12.24
Canyon grass	0.00
Agriculture	0.00
River	0.00
Four-winged Saltbush/Spiny Hopsage	0.00
Greenstrip	4.02
Bare Ground	75.48
Litter	5.10
Other	
Transect Total	700.30

Table 4. Habitat characteristics and Townsend's ground squirrel burrow densities sites on randomly-located sites throughout the Integrations Study Area and Orchard Training Area. Habitat type was initially classified from GIS current vegetation map described in Table 2. Definitions for species richness, S, and diversity, H, are given in text. Cows, sheep, and tank indexes were the presence/absence (1/0) along each 100-m segment of the burrow count transect.

Tran. No.	Hab. Type	UTM East	UTM North	No. Act. B/ha	No. Inact. B/ha	S	H	Dom. Veg. Sp.	Dom. Veg. %	Cows	Sheep	Tank
BOP007	1	546428	4801655	5	20	4	2.04	ARTR	27	0	1	0
BOP026	1	553370	4799578	30	30	5	2.14	ARTR	26	4	0	0
BOP034	7	593430	4782735	0	10	6	2.31	BRTE	16	3	0	0
BOP037	7	596884	4774291	0	30	6	2.37	AGCR	16	4	0	0
BOP039	4	554331	4780492	5	75	7	2.59	CELA	1	3	4	0
BOP049	2	544323	4799597	30	65	5	2.30	ARTR	9	3	0	0
BOP059	7	556353	4787552	15	40	5	1.69	SAKA	21	4	1	0
BOP074	5	584919	4773113	0	10	6	1.94	SAKA	13	4	0	0
BOP094	1	549247	4803078	0	30	3	1.91	ARTR	25	3	0	1
BOP107	9	553741	4788136	20	0	3	1.84	SAKA	27	0	0	0
BOP121	7	592485	4783604	5	0	6	2.66	AGCR	16	4	1	0
BOP138	7	554146	4783373	15	30	7	1.73	BRTE	34	4	4	0
BOP143	7	597243	4762643	0	0	3	1.35	BRTE	31	4	0	0
BOP146	7	571738	4770473	0	35	1	1.00	SAKA	28	2	3	0
BOP148	1	560749	4788084	35	85	7	2.84	ARTR	17	4	0	0
BOP161	1	541706	4806848	5	10	4	1.98	ARTR	39	0	0	0
BOP177	7	582797	4769732	0	5	2	1.00	SAKA	39	1	0	0
BOP186	7	592602	4783789	0	5	6	3.06	BRTE	19	4	2	0
BOP190	7	594767	4763722	0	0	2	1.06	BRTE	8	4	1	0
BOP191	5	571839	4766317	0	0	9	4.35	SAKA	13	0	0	0
BOP327	5	584313	4768593	0	10	6	3.31	SAKA	13	3	0	0
OTA002	2	560455	4784104	0	10	6	3.44	ATCO	10	3	0	4
OTA011	6	568222	4780253	5	60	3	1.13	SAKA	41	2	2	4
OTA050	1	557221	4798496	15	55	3	1.55	SAKA	29	4	0	4
OTA053	1	571364	4786007	0	60	4	1.76	SAKA	28	0	0	4
OTA061	1	578276	4786216	0	5	5	1.86	SIAL	43	0	0	2
OTA062	1	574008	4791941	10	70	7	3.17	SAKA	20	0	0	1
OTA091	1	576203	4782525	0	30	4	1.72	SAKA	30	0	0	0
OTA099	4	562647	4784784	0	30	5	1.50	ARTR	24	2	0	4
OTA136	1	574024	4777330	0	5	3	1.15	SAKA	35	2	0	4
OTA137	7	574028	4785245	0	20	4	2.18	SAKA	25	0	0	0
OTA153	7	557633	4794069	25	70	4	1.26	SAKA	18	4	0	4
OTA163	7	559316	4801168	15	15	5	1.76	BRTE	26	3	0	3
OTA198	6	574811	4777171	0	0	5	1.22	SAKA	36	4	3	0
OTA201	1	578483	4783460	0	35	6	2.08	SAKA	22	0	0	4
OTA230	1	563699	4798967	15	25	4	1.26	ARTR	46	2	0	4
OTA232	1	577095	4779402	0	5	5	1.70	SAKA	28	3	0	2
OTA259	5	577955	4775605	0	0	6	1.84	SAKA	29	4	2	4
OTA295	5	578479	4777964	0	10	6	1.68	SAKA	25	4	0	0

OTA297	7	576146	4773653	0	35	6	1.17	SAKA	29	4	1	3
OTA308	7	565137	4802141	25	100	6	2.19	BRTE	23	4	0	3
OTA342	7	574164	4784664	0	35	5	1.23	SAKA	40	1	0	0
OTA347	7	565382	4801534	15	90	5	2.53	SAKA	17	4	0	4
OTA354	6	563311	4779213	15	145	4	2.84	CELA	10	4	4	4

AGCR = crested wheatgrass, ARTR = big sagebrush, ATCO = shadscale, BRTE = cheatgrass, CELA = winterfat, SAKA = Russian thistle, SIAL = tumblemustard

diversity, both by species richness and relative contribution to the sample.

No significant habitat associations for ground squirrels were identified in preliminary analysis of the 44 randomly-selected sites using direct linear regression (PROC REG, SAS Statistical Inst. 1988) of counts of ground squirrel burrows (total, active, and inactive) with habitat variables, including livestock and military presence. Similarly, habitat ordinations using detrended correspondence analysis (ter Braak and Prentice 1988) with the computer program CANOCO (ter Braak 1988) were inconclusive.

Number of burrows of Townsend's ground squirrels was not significantly different between sites based on presence or absence H, ranged from 1 to 4.35 for the randomly-selected sites (Table 4). The value for H approaches 1 as single species dominate the sample. Larger values of H are influenced of military tracking (Student's t-test, $P > 0.10$) for the randomly-selected sites (Table 6). Similarly, number of burrows in the 44 randomly-selected sites was not significantly different between sites that have evidence of livestock compared to sites with an absence of livestock (tracks or fecal pats along the transect center) (Student's t-test, $P > 0.10$) (Table 6).

The coefficient of variation ranged from 0-8.4% of the population estimate for the 10 transects sampled to determine the bias associated with observer ability to detect and classify burrows on ground squirrel transects (Table 7). The transect with the largest variance, OB07, was located in big sagebrush (*Artemisia tridentata*) habitat. The largest potential for error in counting burrows was due to classification between active and inactive burrows and ranged from 0-44% of total N.

Black-tailed Jackrabbits

Densities of black-tailed jackrabbits along spotlight transect routes were estimated at 0.30/ha (0.28-0.32, 95% C.I.) for all habitats and 0.50/ha (0.27-0.73, 95% C.I.) for sagebrush communities. Despite increased numbers of jackrabbits observed on transect routes, estimates of densities (determined from the probability detection functions in program TRANSECT [Burnham et al. 1980]) decreased from 1989 results (Fig. 2, 3).

Density estimates were compared for 1, 2, or 3 replications on each transect (Table 8). Additional replications did not provide a relative increase in precision that justified multiple sampling on each transect.

We also observed 50 Nuttall's cottontail rabbits, 4 pygmy rabbits, 1,256 kangaroo rats, and 146 mice and voles on spotlight transects (Table 9). Density estimates were not determined for these prey species.

DISCUSSION

Townsend's Ground Squirrels and Habitats

From 1987-89, 81 transects have been sampled in the SRBOPA, excluding the OTA

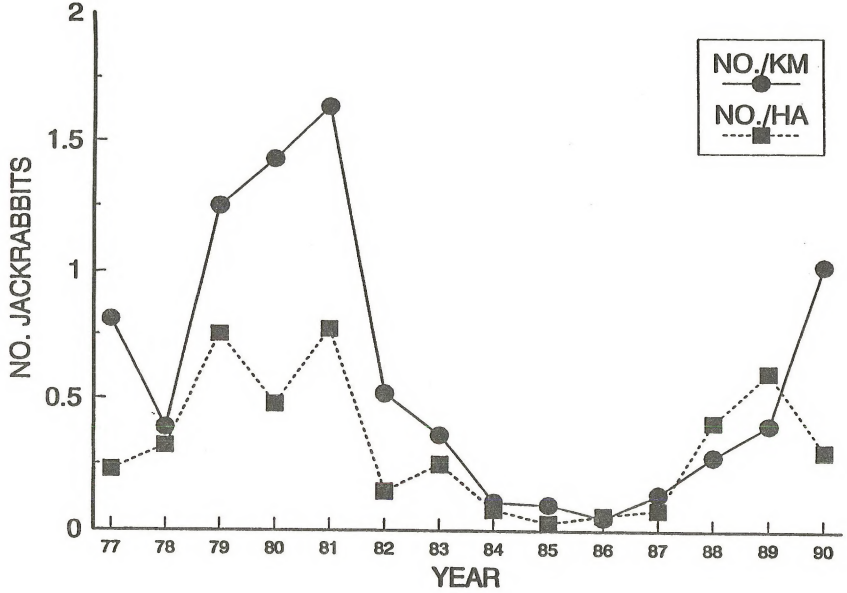

Fig. 2. Densities and number of observations (per km) of black-tailed jackrabbits in all habitats in the Snake River Birds of Prey Area from 1977 through 1990.

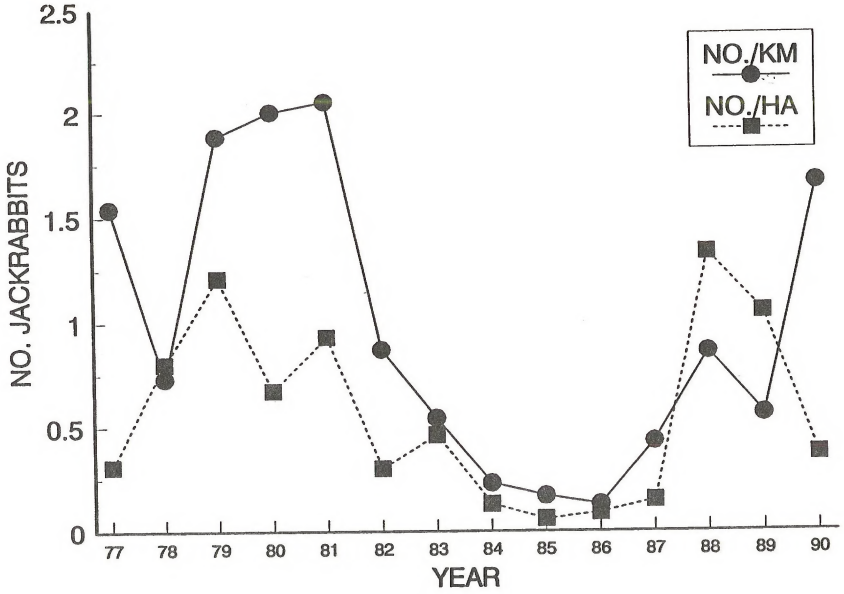

Fig. 3. Densities and number of observations (per km) of black-tailed jackrabbits in sagebrush habitats (Types 01, 02, 03, 22, 23, 24, 41, 42, 43) in the Snake River Birds of Prey Area from 1977 through 1990.

Table 5. Density of active Townsend's ground squirrel burrows (n/ha) on 54 established transects in the Snake River Birds of Prey Area. Counts were obtained from 5 x 400-m strip transects. Data from 1982-1989 are from Wheeler et al. (1989). Habitat descriptions for each site are given in Wheeler et al. (1989).

Tran	1982	1986	1987	1988	1989	1990
4	735	315	505	455	410	135
5	131	230	320	55	85	160
6	232	180	240	80	65	75
7	373	260	645	225	175	65
13	624	370	120	275	210	15
14	342	100	250	315	185	20
15	453	150	625	295	265	15
16	322	340	470	255	235	0
17	201	130	95	50	85	5
18	322	340	230	120	100	15
20	60	55	55	80	50	0
21	60	25	105	95	115	---1
22	483	35	70	50	35	20
23	70	40	95	85	85	30
24	131	35	55	65	40	25
26	584	5	170	80	165	140
33	101	70	155	60	70	135
34	242	30	55	35	25	45
35	322	120	195	25	135	255
50	393	105	115	60	70	70
51	111	45	30	50	45	45
53	121	15	15	20	15	0
54	201	15	30	0	0	10
55	262	20	145	5	150	15
56	363	270	560	170	200	35
57	201	180	330	170	230	25
121	121	170	110	80	115	25
122	0	0	0	0	25	0
123	20	0	0	0	0	0
124	20	25	15	0	5	0
125	0	0	10	0	30	0
126	0	0	5	0	0	0
127	252	0	15	0	0	5
128	50	0	15	30	0	0
147	101	5	30	15	5	0
148	50	5	10	5	5	0
149	111	0	5	0	10	20
150	10	5	0	0	5	0
151	0	0	0	0	0	0
152	30	0	10	0	0	0

161	10	0	20	15	15	0
162	232	30	30	20	35	0
165	30	60	60	60	60	0
172	141	90	115	65	100	20
182	50	30	5	10	20	0
183	40	0	65	5	0	0
200	222	25	100	20	60	85
201	332	20	830	0	5	30
202	796	75	725	15	100	20
203	70	65	100	65	70	25
204	50	20	30	30	35	5
205	141	10	35	20	0	10
206	81	15	55	25	25	0
207	60	0	30	0	10	5
Total	10460	4130	8105	3655	3955	1575
Mean	193.3	76.5	150.1	67.7	73.2	29.7

[1] Site 21 was not sampled in 1990 because of inability to locate transect.

(Quinney et al. 1987, Timmerman et al. 1988, Wheeler et al. 1989). These included 54 transects sampled in 1982 and 1986, 16 established in 1986 to monitor small mammal response to wildfire in shadscale communities (Groves and Steenhof 1988), and 11 established in burned areas that had been reseeded (Timmerman et al. 1988).

Number of active burrows counted on traditional transects in 1990 were approximately one-half of the numbers

Table 6. Number of burrows of Townsend's ground squirrels on randomly-selected sites in the Snake River Birds of Prey Area relative to presence/absences of military tracks or livestock. None of the differences were significantly different (Student's t-test, $P > 0.10$).

	No. of Burrows (Mean ± SE)		
	Active	Inactive	Total
Military Tracking			
Present	7.4 ± 2.1	44.5 ± 8.9	51.8 ± 10.3
Absent	17.9 ± 8.4	29.6 ± 6.2	47.5 ± 13.1
Livestock			
Present	10.3 ± 2.6	36.2 ± 5.9	46.5 ± 7.7
Absent	26.0 ± 22.2	33.5 ± 11.0	59.5 ± 31.0

Table 7. Observer bias associated with counts of Townsend's ground squirrel burrows on 10 transects in the Snake River Birds of Prey Area in 1990. Results were estimated from the 2 sample capture-recapture method (Seber 1982:59). Total population size, $\underline{N}$, and variance, $\underline{V(n)}$, was determined from the numbers of burrows counted by 1 team (n_1 or n_2) and the burrows that were detected by both teams ($n_{1,2}$).

TRAN	n_1	n_2	$n_{1,2}$	N	V(N)
OB01	35	36	24	52.28	10.82
OB02	39	51	29	68.33	16.40
OB03	9	8	5	14.00	4.29
OB04	42	39	35	46.78	1.00
OB05	31	15	13	35.57	6.27
OB06	36	33	27	43.93	2.99
OB07	70	36	25	100.04	71.25
OB08	21	17	14	25.40	2.31
OB09	16	9	9	16.00	0.00
OB10	10	16	7	22.38	8.77
TOTAL [1]	309	260	188	427.10	103.86
[2]	239	224	163	328.27	56.41

1/ Includes transect OB07
2/ Excludes transect OB07

counted in 1989 despite widespread perceptions that populations of ground squirrels were at high levels. Total number of burrows (both active and inactive) were similar between years (1989: 108.2 b/ha; 1990: 104.9 b/ha) and suggests that classification of active/inactive burrows accounted for the difference rather than actual population changes. From the observer bias transects, up to 44% of the burrows counted were classified differently between 2 independent teams.

Investigators should recognize that bias does exist in strip transect counts of ground squirrel burrows in addition to the untested assumption that number of burrows represents an actual population parameter. To reduce errors in rate of burrow detection, additional observers can be used locate burrows on transects. If only a single count is conducted, a minimum of 3 people on a team could ensure a higher count of all burrows. The 2-sample estimator can be conducted to provide an estimate of within transect variance.

Interpretation of criteria for classifying burrows as active/inactive were the largest potential source of error. Conducting the transects after squirrels immerged for estivation increased the probability of wind-blown debris or spider webs in burrow entrances. In addition, wind or rain can obliterate trails leading from burrows. Moving the time frame for burrow counts earlier into the season may insure that burrows are more readily interpreted as active if ground squirrel use is concurrent with sampling. For 1991, criteria for classification of active burrows will be defined by results from Study 4 of

Table 8. Comparison of replicates for spotlight counts of jackrabbits along established transect routes (Smith and Nydegger 1985). Density estimates were determined from the Exponential Power Series Estimator using the program TRANSECT (Burnham et al. 1980). (P) χ^2 compares goodness of fit to estimated probability distribution function from the exponential power series estimator.

Run No.	N	D	%C.V.	95% C.I.	P(χ^2)
All Habitats					
1	213	0.29	6.85	0.25 - 0.33	0.40
2	200	0.26	47.68	0 - 0.50	0.06
3	299	0.34	5.78	0.30 - 0.37	0.01
1, 2	413	0.28	79.20	0 - 0.70	0.19
1, 3	512	0.31	4.42	0.29 - 0.34	0.01
2, 3	499	0.30	4.48	0.27 - 0.33	0.06
1, 2, 3	712	0.30	3.75	0.28 - 0.32	0.07
Sagebrush Habitats					
1	108	0.40	29.53	0.17 - 0.64	0.02
2	113	0.45	38.47	0.11 - 0.79	0.07
3	141	0.55	8.42	0.46 - 0.64	0.01
1, 2	221	0.47	25.16	0.24 - 0.70	0.08
1, 3	249	0.52	32.13	0.19 - 0.84	0.02
2, 3	254	0.51	35.39	0.16 - 0.86	0.17
1, 2, 3	362	0.50	23.77	0.27 - 0.73	0.02

BLM/IDARNG Research Project with additional assistance from personnel involved with burrow counts in previous years in the SRBOPA.

The 2-fold difference in burrow numbers counted on the randomly-selected sites compared to traditional sites may reflect the nonrandom placement of traditional sites in high density locations. In addition, 17 of 44 of the randomly-selected sites were in grass/exotic annual habitats that have lower ground squirrel densities (Wheeler et al. 1989).

Black-tailed Jackrabbits

Jackrabbits have been censused in the Snake River Birds of Prey Area by night spotlight counts using line transect methods since 1977 (Wolfe et al. 1977). In 1979, 10 transect routes (total 187 km; 1.6-52.9 km in length) were permanently established along single-track jeep trails in the Snake River Birds of Prey Area (Smith and Nydegger 1985). One transect in 1987 (16.6 km), 2 transects (13.2, 20.4 km) in 1988, and 1 transect (6.78) in 1989 were added in the Orchard Training Area in 1989.

Black-tailed jackrabbits are cyclic with approximate 7-12 year intervals between peaks (Johnson and Peek 1984). In the Snake River Birds of Prey Area, densities peaked in 1981 and are again in another peak phase of the cycle.

Table 9. Rate of sighting (n/km) within habitat types for small mammals observed during spotlight transects for jackrabbits on the Snake River Birds of Prey Area during spring, 1990.

	Number Observed Per Km of Spotlight Transect			
Habitat	Black-tailed Jackrabbit	Nuttall's Cottontail	Kangaroo Rat	Mice
ARTR	0.55	0.04	0.41	0.06
ARTR/CELA	0.46	0.10	0.38	0.03
CELA/EXAN	0.06		0.45	0.04
CELA	0.14		0.42	
ATCO	0.30	0.01	0.56	0.02
ATCO/CELA	0.18		0.51	0.04
ARTR/CHNA				
AGCR	0.08	0.01	0.80	0.05
GRSS/EXAN	0.24	0.01	0.79	0.16
CHNA		0.07	0.22	0.07
ARTR/ATCO	1.09		0.29	
SAVE/ATCO	0.44		0.29	
SAVE	0.22		0.33	
ATNU				1.71
CANYON SHRUB	0.05		0.11	0.05
GREENSTRIP	1.33	0.41	0.50	
BARE GROUND	0.01	0.01	1.33	0.10
LITTER				
LEPE	0.16		0.04	0.04
ALL TRANSECTS	1.02	0.07	1.79	0.21

AGCR = crested wheatgrass, ARTR = big sagebrush, ATCO = shadscale, ATNU = Nuttall's saltbush, CELA = winterfat, CHNA = rabbitbrush, EXAN = exotic annual, GRSS = grass, LEPE = peppergrass, SAVE = greasewood

Estimates of jackrabbit densities decreased in 1990 from 1989 levels although rate of jackrabbit observations increased for all habitats combined and for sagebrush habitats. Our methods were similar between years and personnel were the same for >40% of the census distance. Fewer jackrabbits were counted in 1989 but the relative distribution of observations close to the center line was higher than in 1990 and accounted for the higher estimate of density. The number of observations in 1989 at 1 m were greater than on the center line and violated the line transect assumption that observations decrease with increasing distance from the center (Burnham et al. 1980). However, grouping the results into 5 m categories to obtain a better fit did not alter the density estimate.

PLANS FOR NEXT YEAR

Townsend's Ground Squirrels and Habitats

The sampling effort for ground squirrels and habitats will be expanded to 500 sites randomly selected throughout the Integration Study Area and the OTA. We will continue to conduct burrow counts on the traditional transects and all of the randomly-selected sites from 1990 to define yearly variation in populations and habitats (Fretwell 1972, Southwood 1977, Hanski 1985). Spatial distribution of ground squirrel burrow counts and habitat variables will be modeled by contouring functions on the GIS.

Resiliency of Townsend's ground squirrel populations and habitats to military tracking will also be assessed by manipulated tracking within a random block design entirely within a habitat type. Counts of ground squirrel burrows and vegetation sampling will be conducted in each year during pre/post tracking periods to estimate influence of military tracking.

Black-tailed Jackrabbits

We will continue spotlight counts for estimates of spring densities on traditional transects. Because multiple replications on transects did not provide an appreciable increase in precision of the density estimates, we will sample each transect once and add additional routes to increase the area and treatments sampled. We will survey traditional and new transects throughout the SRBOPA by spotlight methods (Smith and Nydegger 1985) during December to determine winter jackrabbit densities and distribution.

ACKNOWLEDGMENTS

I thank M. Blew of the Idaho Army National Guard and J. Doremus of the Bruneau Resource Area, and N. Cummings, R. I. Dice, B. T. Helmich, T. Weiss, and L. P. Williams of Study 5 for field assistance.

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Raptor and Raven Nesting on the PP&L Malin to Midpoint 500-kV Transmission Line

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Annual Summary

Long-term, extensive monitoring of nesting densities on the 500-kV transmission line began in 1990. A single helicopter survey in early May located 125 nesting pairs, but past research indicates that 4-15% of the population could have been missed on a single survey. As in past years, nesting densities were highest near the Snake River Canyon.

OBJECTIVE

To identify all occupied raptor and raven nests on the first 371 miles of the PP&L Malin to Midpoint 500-kV transmission line.

INTRODUCTION

Construction of a 500-kV transmission line across southern Idaho and Oregon in 1980-81 provided government and industry biologists with an opportunity to investigate the biology of raptors and ravens nesting on transmission lines. Pacific Power & Light Company (PP&L), in cooperation with the U.S. Bureau of Land Management (BLM), has surveyed the 500-kV transmission line between Midpoint (Jerome), Idaho and Malin, Oregon (Fig. 1) since 1981, and intensive research was carried out from 1984 through 1989. In 1990, less intensive long-term monitoring of nesting populations began. This report presents findings of the 1st year of long-term monitoring.

METHODS

The entire line was surveyed by PP&L personnel from a Messerschmidt Boelkow helicopter on 1 and 2 May to locate nesting pairs. Individual nests along a portion of the line were spot-checked by BLM personnel from a Bell 206 Jet Ranger on 14 March and 4 June during golden eagle surveys. During

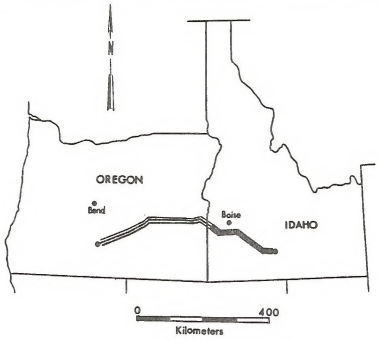

Fig. 1. Location of the Pacific Power and Light 500-kV transmission line. Intensive survey stretch is shaded.

all surveys helicopters were flown at speeds of 70-95 km/hr; we usually hovered approximately 10 m from nests for 5-25 sec to view nest contents. Several hawk and eagle nests in Idaho were re-checked from the ground in June to ascertain productivity.

Pairs were considered "breeding" if they laid at least 1 egg; this was confirmed by observing eggs, young, or an incubating adult. Because aerial surveys covered only the power line structures, some nonbreeding pairs could have been missed.

RESULTS

Nest Density and Distribution

In 1990, we located 125 pairs of raptors and ravens associated with nesting sites on the 500-kV transmission line. Breeding attempts were confirmed for 122 of the 125 nesting pairs on the line. Breeding could not be confirmed at 1 occupied red-tailed hawk (*Buteo jamaicensis*) nest, 1 common raven (*Corvus corax*) nest, and 1 ferruginous hawk (*Buteo regalis*) nest. There were no confirmed re-nesting attempts in 1990.

Ravens were still the most numerous species nesting on the line. Seventy-four raven, 33 red-tailed hawk, 7 ferruginous hawk, 9 golden eagle, and 2 great horned owl (*Bubo virginianus*) pairs occupied nesting territories on the line in 1990 (Table 1). The 125 occupied nesting territories represent a decrease from levels observed from 1987-1989 (Table 1). However, some pairs may have been missed in the single May survey. Analyses of data from 1985-1989 (Steenhof et al. 1989) indicated that early May surveys

Table 1. Number of occupied raptor and raven nesting territories found on the PP&L Malin to Midpoint 500-kV transmission line, 1981-1990.

Species	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Golden Eagle	1	2	5	4	4	4	7	8	8	9
Ferruginous Hawk	1	3	9	7	6	8	9	12	11	7
Red-tailed Hawk	0	2	2	13	20	28	33	27	33	33
Common Raven	1	9	39	55	58	73	81	80	81	74
Great Horned Owl	0	0	0	0	0	0	1	1	1	2
TOTAL	3	16	55	79	88	113	131	128	133	126

identified a 85-96% of all known nests on the transmission line. If this was the case in 1990, then the actual number of nests on the line in 1990 was between 130-147.

Great horned owls nested on the line for the first time since 1988; 1990 was the first year that more than 1 owl pair nested on the line. Numbers of red-tailed hawk pairs found were the same as in 1989, golden eagle pairs increased by 1, and both ferruginous hawk and raven numbers decreased on the line. Ravens are the species most likely to be missed on a single survey. Of 19 historical ferruginous hawk nesting territories associated with the transmission line, only 8 were occupied in 1990, and only 7 pairs nested on the line itself. In Mile 111 where ferruginous hawks have nested successfully each year since 1987, a ferruginous hawk pair nested successfully on a rock outcrop, 250 m from the nearest transmission line tower (111/2). Shields and pegging had been placed on this pair's nesting tower during the 1989 nesting season, and the disturbance may have caused the pair to relocate. Three ferruginous hawk sites where pairs nested in 1989 (Miles 66, 72, and 88) had no birds in 1990.

Golden eagles nested in Mile 1 for the first time in 1990. They used a platform nest that had been used in past years by red-tailed hawks. The eagle pair that nested at Mile 125 in 1988 did not nest on the line in 1990. As in the past 2 years, the golden eagle pair at Little Canyon Creek (49/3) nested on one of the traditional cliff nests, approximately 400 m from the line.

The number of raptor and raven pairs decreased by 5 from 1989 levels in the intensive study area (Miles 1-133) and by 3 in the extensive area. As in past years, nesting densities of all species combined were higher in the intensive study area (0.31

per km; 0.5 per mi) than in the extensive area (0.15 per km; 0.24 per mi). For the entire line, densities averaged 0.21 nests per km or approximately 8 nests for every 100 towers.

Significantly more breeding pairs occurred between Miles 59 and 127, within or just north of the Snake River Birds of Prey Area (SRBOPA), than in the remaining half of the intensive study area ($X^2 = 7.23$, $P < 0.05$). As in past years, nesting densities were particularly high along one stretch of line within the SRBOPA (Miles 113-119). In 1990, this stretch contained 1 nesting pair per mile (0.7 per km), more than 3 times the average density for the line.

ACKNOWLEDGMENTS

This study was made possible by Pacific Power and Light Company. We thank Genna Poulson who assisted with data compilation. We are also indebted to our pilot: John Judge (Pacificorp).

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Implications of Communal Roosting by Common Ravens to Operation and Maintenance of Pacific Power and Light Company's Malin to Midpoint 500-kV Transmission Line

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Annual Summary

Ravens were observed to use 3 of 6 roosts on the Pacific Power and Light Company's 500-kV transmission line between May and November, 1990. Numbers of ravens were generally lower than those observed in previous years' studies. Shields and pegging appear to be an effective deterrent to fecal contamination of insulator strings on transmission towers.

OBJECTIVE

Monitoring was conducted to determine use of transmission line towers by common ravens (*Corvus corax*), levels of fecal contamination on insulators, and effectiveness of protective shields and pegging at 6 roosts on Pacific Power and Light Company's Malin to Midpoint 500-kV transmission line.

METHODS

Six roost sites were monitored from May to November, 1990. These sites had been determined to be significant communal common raven roost sites during studies of implications of roosting to operation and maintenance of the transmission line from 1983 to 1987 (Young and Engel 1988).

Contamination estimates were made at towers at the Wilson Creek and Initial Point roosts in May and November. Estimates were made according to procedures described by Young and Engel (1988). At the Wilson Creek roost, 8 towers (3/130 through 1/132) were scored on 17 May and 12 November. Twenty towers between towers 3/107 and 4/112 at the Initial Point roost were scored on 9 May and 17 November. Contamination estimates were not conducted for towers 3/110 and 4/110, where insulators are made from an opaque ceramic material, and 1/110 where the turn-tower configuration precludes contamination. Spring and autumn contamination scores for inner and outer strings of insulators on each tower were compared using a 2-sample median test.

Evening counts of roosting ravens at Wilson Creek and Initial Point were conducted once monthly from May through October. An observer with a spotting scope was positioned approximately 500 m from the transmission line. Beginning 30 min before sunset, the number of ravens on each section of each tower of the roost was counted at 10-min intervals. Observations concluded 30 min after sunset or when it became too dark to count, whichever came first. The highest number of ravens observed during any one 10-min interval was considered the night's count for the roost.

Four other roosts, Pleasant Valley (1/101 through 4/104), Marsing Dump (2/148 through 2/150), Marsing Southwest (3/153 through 5/156), and Alkali Flat (1/159 through 4/160) were checked monthly for indications of occupancy. One of 2 methods were used to determine occupancy. Shields and insulators were visually inspected for fecal contamination or an evening observation was conducted, using methods described above.

Of the 6 roosts monitored, 3 have protective shields and pegging as described by Beck (1989) and Young and Engel (1988). Shields and pegging at Initial Point, Wilson Creek, and Marsing Southwest were inspected from the ground for damage and contamination.

RESULTS

Occupancy of Roosts

At Initial Point, roosting ravens were observed each month (Table 1). The highest number observed was 600 birds on 6 towers on 21 July at 10 min after sunset. Low counts were 2 and 4 ravens on 9 May and 14 June, respectively. On 22 August, 527 ravens roosted on 11 towers at 20 min after sunset. Seven towers were used by 318 birds on 25 September, 3 towers by 219 birds on 25 October. High counts were made at 30 min after sunset in September and October. No clear pattern of tower use emerged over the monitoring period. No birds were observed roosting on towers 4/111 through 4/112 or towers 2/107 through

Table 1. Use of towers at the Initial Point roost by common ravens, May through October 1990.

Date	Number of birds	Number of towers	Towers used	Time of high count
5/9	2	1	3/111	SS + 20 min
6/14	4	4	4/110, 1/111, 2/111, 3/111	SS - 20 min
7/21	600	6	2/108, 4/108, 5/108*, 1/109, 4/110, 5/110	SS + 10 min
8/23	527	11	3/108, 4/108, 1/109, 2/109, 3/109*, 4/109, 2/110, 3/110, 4/110. 1/111, 2/111	SS + 20 min
9/25	318	7	2/109, 3/109, 4/109*, 3/110, 4/110, 5/110, 1/111	SS + 30 min
10/25	219	3	2/110, 3/110, 4/110*	SS + 30 min

SS = sunset
* tower with highest count

1/108 over the 6-month period. Towers 2/110 and 3/110 (3 observation evenings) and 4/110 (5 observation evenings) were most frequently used.

The Wilson Creek Roost was occupied on 4 of 6 observation nights (Table 2). No ravens were observed on 11 May or 25 October. On 11 June, 3 ravens were observed roosting on tower 1/132 at 20 min after sunset. Seventy-six birds were counted on 3 towers 22 July. A total of 398 ravens was counted among 6 towers on 23 August. On 30 September, 56 birds roosted on 1 tower. Time of highest count was 30 min after sunset all months except June, when the high count occurred at 20 min after sunset. Towers 5/131, 1/132, 2/132, and 3/132 were all occupied on 2 of the 6 observation nights.

There was no evidence of large numbers of roosting ravens at the Pleasant Valley roost during the monitoring period. Insulators were generally clean, and searches for feathers and pellets at the bases of towers gave no indication of use by large numbers of ravens. No evening counts were conducted at the Pleasant Valley roost.

There were indications of raven use of towers at the Marsing Dump site throughout the latter part of the monitoring period. On 17 May and 14 June, a moderate level of contamination was observed on tower 4/148. Inspection of towers on 22 July revealed extremely heavy accumulation of feces on insulators on tower 5/148 and moderate contamination on 4/148. An evening roost watch was conducted on 22 August, 156 birds were observed on 5 towers at 20 min after sunset. The greatest number of birds used tower 2/148. Two and 8 birds were observed on 5/148 and 4/148, respectively. In September, observations of insulator contamination showed moderate to very heavy accumulation of feces at towers 2/148 through 2/149. At a final evening count on 25 October, 12 ravens were distributed between towers 2/148 and 3/148.

Table 2. Use of towers at the Wilson Creek roost by common ravens, May through October 1990.

Date	Number of birds	Number of towers	Towers used	Time of high count
5/11	0	---	---	---
6/11	3	1	1/132	SS + 20 min
7/22	76	3	1/132, 2/132*, 3/132	SS + 30 min
8/23	398	6	3/131, 4/131, 5/131, 1/132, 2/132*, 3/132	SS + 30 min
9/30	56	1	5/131	SS + 30
10/25	0	---	---	---

SS = sunset
* tower with highest count

Insulators on towers at the Marsing Southwest Roost remained free of opaque contamination throughout the monitoring period. In May and June, shields on towers 1/155 through 4/155 showed moderate contamination. An evening roost watch was conducted 22 August. Four towers were occupied by 149 ravens at 30 min after sunset.

Insulators on towers at the Alkali Flat roost inspected from the ground showed no accumulation of feces throughout the monitoring period. There were no other indications of raven use.

Contamination

There was no change in contamination scores for 16 of 22 towers at the Initial Point roost (Table 3). Three towers (3/109: χ^2 = 13.24, $P < 0.05$, 3/111: χ^2 = 7.526, $P < 0.05$, 1/112: χ^2 = 12.70, $P < 0.05$) showed decreased contamination on the outer strings of insulators, and at 1 tower (2/108) contamination levels decreased for both the inner (χ^2 = 6.382, $P < 0.05$) and outer strings (χ^2 = 8.69, $P < 0.05$). Towers 3/111 and 1/112 were either never observed to be occupied by roosting ravens or were occupied by only 1 raven at the time of evening counts. Ravens occupied tower 2/108 on 1 occasion, and 3/109 on 2 occasions.

Two towers at Initial Point showed increased contamination. Outer insulator strings on tower 2/110 (χ^2 = 13.53, $P < 0.05$) were more heavily contaminated in November than in June, and was observed to be occupied by roosting ravens on 3 occasions. Both inner and outer insulator strings on tower 4/111 (χ^2 = 11.11, $P < 0.05$ and χ^2 = 13.07, $P < 0.05$) had increased contamination. Ravens were not observed roosting on that tower during the monitoring period.

Of 8 towers scored for contamination at the Wilson Creek roost site, 6 were unchanged over the monitoring period (Table 4). Tower 1/132 had increased contamination (χ^2 = 6.38, $P < 0.05$) on the center insulator strings. It was occupied all 4 evenings that ravens were observed using the roost.

Table 3. Changes in contamination levels observed at the Initial Point roost, 1990. Insulators on the other 16 towers in the roost showed no significant change in contamination levels.

	Contamination Trend (May through November)			
Tower		Center Insulators		Outer Insulators
2/108	D	(χ^2 = 6.382, $P < 0.05$)	D	(χ^2 = 8.695, $P < 0.05$)
3/109	N		D	(χ^2 = 13.24, $P < 0.05$)
2/110	N		I	(χ^2 = 13.53, $P < 0.05$)
3/111	N		D	(χ^2 = 7.526, $P < 0.05$)
4/111	I	(χ^2 = 13.07, $P < 0.05$)	I	(χ^2 = 11.11, $P < 0.05$)
1/112	N		D	(χ^2 = 12.70, $P < 0.05$)

D = significant decrease, I = significant increase, N = no significant change

Table 4. Changes in contamination levels observed at the Wilson Creek roost, 1990. Insulators on the other 6 towers in the roost showed no significant change in contamination levels.

	Contamination Trend (May through November)			
Tower	Center Insulators		Outer Insulators	
5/131	N		I	($\chi^2 = 36.16$, $P < 0.05$)
1/132	I	($\chi^2 = 6.38$, $P < 0.05$)	N	

D = significant decrease, I = significant increase, N = no significant change

There was an increase in contamination level on the outer strings of tower 5/131 ($\chi^2 = 36.16$, $P < 0.05$), which was occupied by ravens twice during monitoring.

Condition of Shields and Pegging

Shields and plastic pegging installed at the Initial Point roost in 1989 remained in place and intact through the 1990 monitoring period. Considerable amounts of debris had accumulated on shields on towers from 2/109 through 4/110.

At the Wilson Creek roost, shields remained in place and showed no indication of damage. At no tower does the wooden pegging installed in 1985 remain in place.

Shields at Marsing Southwest show no evidence of damage or deterioration, though some (2/155 through 5/155) are moderately contaminated. No pegs are in place there.

DISCUSSION

The monitoring effort for the 1990 season was low in intensity, and the data gathered are insufficient for quantitative analysis of tower use at individual roosts or use of individual sections of towers. What is discernable from the data gathered is which roosts are being used by relatively large numbers of birds. The Initial Point, Wilson Creek, and Marsing Dump roosts were observed to be occupied by large groups of ravens.

Ravens used towers at Initial Point for roosting throughout the study period. The maximum count of 600 was lower than that for 1989 (Beck 1989), and substantially lower than the historic maximum count of 2,103 ravens in July, 1984. Seasonal patterns of tower use were similar in 1990 to previous years, with maximum counts occurring in July and August each year since 1984.

Use of towers at Wilson Creek by roosting ravens in 1990 peaked at 398 individuals in August. The highest number of ravens observed at this roost was 559 in 1984 (Young and Engel 1988). Spring use of the roost site was documented by Young and Engel (1988) for 1985 and 1986, but not 1987. No spring use was documented in 1990.

Of the 4 other roosts observed, only Marsing Dump showed effects of heavy use by

roosting ravens. This site had a high count of 613 ravens in August 1984. Although insulators at the roost have been washed in the past, it has not been treated with shields and pegging (Young and Engel 1988).

Shields and pegging at the Initial Point roost appear to be effective in protecting insulators from contamination. Increased contamination was observed at 2 towers. Tower 2/110 had increased levels of contamination on the outer insulator strings and was occupied 3 of 6 observation nights. Buildup of contamination was not judged by the author to be serious enough to warrant washing and probably is not sufficient to cause a line trip. Tower 4/111 had higher contamination scores for inner and outer insulator strings at the end of the monitoring period. Birds were never observed roosting on that tower. The increase may be attributable to observer error or roosting activity which was not observed. As with tower 2/110, contamination is not likely to be a serious detriment in terms of line operation. Improved contamination scores on 4 towers may be a function of weathering, and have no implications for line operation.

Although pegging installed at the Wilson Creek roost in 1985 has fallen from most of the towers, shields appear to provide adequate protection for the current level of raven use. Two towers showed increases in contamination in either the inner or the outer strings of insulators.

Because the monitoring effort in 1990 was not intensive at either the Initial Point or Wilson Creek roosts, associations between contamination levels and raven use at individual towers cannot be quantified. However, in terms of implications for operation of the power line, shields and pegging appear to be effectively shielding insulators from fecal contamination. At neither site would a line trip (outage) be expected due to accumulation of waste on insulators.

Contamination buildup on towers at the Marsing Dump roost, while not scored quantitatively, appears to be serious enough to warrant concern. Conditions appear to be similar to those described by Young and Engel (1988) in terms of risk for a line trip due to moisture associated with fecal buildup on insulators.

MANAGEMENT RECOMMENDATIONS

Results of 1990 monitoring are the basis of the following recommendations:

1. Towers 2/148 through 2/149 should have insulators washed and be fitted with protective shields and pegging as described by Beck (1989).

2. A low level monitoring effort of all historic and current roosts which are not fitted with protective shields and pegging should take place in 1991. The monitoring should involve periodic checking of insulators for accumulation of feces. This could occur concurrently with other monitoring activity along the powerline. Evening counts or quantitative evaluation of contamination may be recommended where visual observation indicates a high level of use any group of towers along the transmission line.

3. Based on results of contamination scoring in 1989 and 1990, it does not appear necessary to estimate contamination for insulators on towers where shields and pegging are in place.

4. Periodic checks of the condition of shields and pegging at all treated roost sites should continue.

ACKNOWLEDGMENTS

Patrick Haas assisted with roost observations and other monitoring tasks throughout the field season. The following

people provided assistance with evening observations: David Beig, Dawn Gerhardt, Rick Gerhardt, Julie Hilty, Greg Kaltenecker, Paula Phelps, Tad Phelps, and Jeri Williams. Their help is appreciated.

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Use of Nest Boxes by American Kestrels in Southwestern Idaho

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Annual Summary

American kestrels (Falco sparverius) nested in 20 boxes along I-84 and in the vicinity of Kuna, Idaho in 1990. Both occupancy rates (38%) and nesting success rates (84%) were higher than in past years. Seventy-eight kestrels were banded in 1990.

OBJECTIVES:

1. Determine kestrel occupancy rates and nesting success at boxes erected in southwestern Idaho.

2. Mark nestling and adult kestrels to accumulate baseline data for future studies on dispersal and population dynamics.

INTRODUCTION

This study began in 1985 when nest boxes were erected on abandoned power poles in the Snake River Birds of Prey Area in an effort to learn more about the food habits and breeding biology of American kestrels (*Falco sparverius*) in southwestern Idaho (Steenhof et al. 1985). The limited use of those boxes prompted curiosity about factors that influence occupancy rates. In 1986, the Idaho Fish and Game Department's Nongame program joined the study, and the study area expanded to include agricultural and suburban habitat in the Kuna area as well as Interstate 84 between Simco Road and Caldwell. In 1990, BLM had sole responsibility for monitoring.

METHODS

Boxes have been erected for kestrels in 3 separate study areas in southwestern Idaho: on trees within agricultural habitat in the vicinity of Kuna, Idaho (hereafter referred to as the Kuna Route); on highway signs along Interstate 84 between Simco Road and Caldwell (hereafter referred to as the I-84 Route); and on abandoned power poles along the north rim of the Snake River Canyon (hereafter referred to as the BOPA route). Monitoring in 1990 focused on the boxes on the Kuna and I-84 routes because of high vandalism and low kestrel occupancy rates on the BOPA route (Steenhof 1989). In 1990, 27 boxes were available on the I-84 route, and 26 were available on the Kuna route. Four boxes on each of these routes have been destroyed since the study began.

Each box on the Kuna route and I-84 route was checked at least once in late May or early June. The BOPA boxes were only checked opportunistically. All boxes with

viable nesting attempts were re-visited as necessary to band young and ascertain nesting success. Nests with young that were 75% feathered were considered successful. Investigators checked boxes while standing on a ladder. When checking boxes, investigators inserted a hole stuffer into the nest box entrance to trap any adult birds in the box. Adults and young were weighed with a 300-g Pesola balance. Kestrel eggs that did not hatch after the normal period of incubation were collected and stored in a refrigerator. Nests of European starlings (*Sturnus vulgaris)* were removed in an effort to keep all boxes suitable for kestrel nesting.

RESULTS

Twenty (38%) of 53 available boxes on the Kuna and I-84 routes were used for nesting by kestrels in 1990. The 1990 box occupancy rate was higher than the rates observed on these 2 routes in every year except 1987 (Table 1). Occupancy rates on the I-84 and Kuna routes were nearly identical in 1990, with 10 boxes occupied on each route. As in past years occupancy rates on the I-84 were higher west of Meridian (7 of 16 boxes occupied) than east of Boise (3 of 11 occupied). No nesting kestrels were found on the BOPA route in 1990, but not all boxes were checked.

Only 2 of the boxes were used by kestrels for the first time in 1990. Eight of the boxes used by kestrels had been used in 1989, and 7 were last used in 1988. Two had not been used since 1987, and one had not been used since 1986.

Overall nesting success of 19 kestrel pairs in 1990 was 84%, higher than in any previous year (Table 2). Success rates were similar on the I-84 and Kuna routes, with 8 successful pairs on each route. Two of the 3 unsuccessful nests failed during incubation, and the third failed soon after hatching. All nest failures were attributed to abandonment. Five successful nests had at least 1 egg which failed to hatch, and a nestling also died at 1 of these sites. We received reports of 3 banded kestrels that died as post-fledgings in 1990. All 3 died within 100 m of their natal box. A fledgling male from Kuna Box #108 was killed by a car, and 2 siblings from I-84 Box #8 died of unknown causes.

Observed clutch sizes were 4 and 5 in 1990 (mean = 4.9). In addition, we also found a

Table 1. Occupancy rates of kestrel boxes on the Kuna and I-84 routes, 1986-1990. Number of available boxes in parentheses.

	I-84	Kuna	Overall
1986	24% (17)	18% (17)	21% (34)
1987	41% (32)	39% (31)	40% (63)
1988	30% (30)	40% (30)	35% (60)
1989	28% (29)	27% (30)	27% (59)
1990	37% (27)	38% (26)	38% (53)

Table 2. Percent of kestrel nests successful on the Kuna and I-84 routes, 1986-1990. Sample sizes in parentheses.

	I-84	Kuna	Overall
1986	0% (3)	100% (4)	57% (7)
1987	54% (13)	55% (11)	54% (24)
1988	44% (9)	50% (12)	48% (21)
1989	25% (8)	75% (8)	50% (16)
1990	80% (10)	89% (9)	84% (19)

nest with 6 fledging-age young. This was the second consecutive year that a brood of 6 has been observed in this area. Overall, brood size at fledging ranged from 3 to 6 and averaged 4.42 ($\underline{n}$ = 12). Kuna boxes had lower brood sizes at fledging (4.0) than I-84 boxes (4.8).

We banded 78 kestrels in 1990 (68 nestlings and 10 adults). Of the adults banded, 8 were females, and 2 were males. None of the 10 adults captured were wearing bands when they were caught. Between 1986 and 1989, we banded 168 kestrels (123 nestlings and 45 adults) from boxes on the Kuna and I-84 routes, and none of these birds has been recaptured in a subsequent breeding season. In 1990, 7 of 10 adults were captured at boxes where adult kestrels of the same sex had been banded in prior years. At 2 of these, different females had been banded in 1989. Three different females have occupied both of these boxes. A different female has been captured at Kuna #104 in 1988, 1989, and 1990, and different females have used I-84 Box #11 in 1987, 1989, and 1990. A male was captured in 1990 at a site where a different male had bred in 1987. At 2 boxes, the females captured were different from the females captured in 1988, and at 2 other boxes, females captured were different from those captured in 1986. These findings, along with similar findings in past years, suggest either that kestrel nest site fidelity is low or mortality is high in this study area.

Starling eggs or young were found in 18 of the 53 boxes, and house sparrows (*Passer domesticus)* nested in 3 boxes. Starling occupancy rates were highest along the I-84 route (52%), particularly east of Boise, where 8 of 11 boxes had sparrow nests. Twelve boxes had no confirmed use by any species during the nesting season.

Weights of adult females ranged from 119 to 151 g and averaged 135 g ($\underline{n}$ = 5; SD = 13). The lightest female was captured while brooding small young; the lightest incubating female weighed 127 g. Weights of adult males ranged from 99 to 115 g and averaged 110 g ($\underline{n}$ = 4; SD = 8).

ACKNOWLEDGMENTS

This study could not have been completed without the field assistance of Virginia Farr, Gerald Griggs, and Genna Poulson.

We are especially indebted to the landowners in the Kuna area who graciously allowed us to set up and check boxes on their property. The National Geographic Society donated a ladder to the study.

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Feeding Ecology of the Barn Owl in the Snake River Birds of Prey Area

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Annual Summary

Surveys of 15 traditional barn owl nest/roost sites revealed that site occupancy remained at the low levels observed for the past 5 years. However, more sites were occupied than in 1989, and considerably larger diet samples in 1990 indicated higher activity by owls. Diet data showed only minor changes in most major prey types. The dominant prey, voles, continued a gradual decline in barn owl diets that began in 1988.

OBJECTIVE

To determine food-niche parameters and food-niche variation among collection sites and among years for barn owls (*Tyto alba*) nesting in the Snake River Birds of Prey Area (SRBOPA).

METHODS

Owl diet data originated from regurgitated pellets that I collected at cliff sites occupied by barn owls. Most sites were occupied barn owl nests. All collections were made from March to August. Prey in the pellets were identified and quantified by standard methods (Marti 1987). See Marti (1988) for treatment of data from earlier years. Results from 1990 were compared with findings from 1979-1989.

RESULTS AND DISCUSSION

Pellet samples were collected at 4 sites on 28 April, 26 May, and 15 August. Collection locations and sample sizes are given in Table 1. The 1990 dietary sample is summarized in Table 2. Frequencies of major prey revealed mostly minor changes from 1989 (Fig. 1). Voles (*Microtus montanus*) declined slightly continuing the trend of the last 3 years. Pocket mice (*Perognathus parvus*) showed the greatest change by declining 7%. The pattern of year-to-year fluctuations in major prey suggests that the owls may have been tracking cyclic prey populations (Fig. 1). However, no prey density data are available to confirm that suspicion.

The decline in number of sites occupied by barn owls that began in the SRBOPA in 1986 may have reversed in 1990. See Table 3 for comparisons of the number of occupied sites and size of diet samples by years.

PLANS FOR 1991

Three trips to the SRBOPA are planned for the spring/summer of 1991. The objectives for 1991 are to continue collecting food habits data for the analysis of long-term predation trends by barn owls and to monitor trends in breeding numbers of barn owls.

Table 1. Collection sites for barn owl diet data and number of prey in collection samples from the SRBOPA, 1990.

	Number of Prey in Samples		
Collection Site	28 April	26 May	15 August
Jensen Cliff	96	109	216
Lower Lower Black Butte	117	240	62
Upper Lower Black Butte	318	595	287
Garbage Draw	82	159	78

ACKNOWLEDGMENTS

I thank Richard Olendorff, Michael Kochert, Karen Steenhof, John Doremus, Gerry Griggs, and all of the Snake River Birds of Prey Research staff for a variety of assistance in carrying out this study. The Bureau of Land Management provided a vehicle for field use and living space in field camps. Weber State University provided a Faculty Research Grant covering travel to the study area from Ogden, Utah, and laboratory space and computer facilities for data analysis.

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Table 2. Total prey identified for the barn owl in the SRBOPA, 1990.

Prey species	Number	Percent number
MAMMALS		
Sorex vagrans	4	0.2
Mus musculus	234	9.9
Peromyscus spp.	254	10.7
Reithrodontomys megalotis	105	4.4
Microtus montanus	1084	45.8
Neotoma lepida	9	9.2
Perognathus parvus	58	2.4
Dipodomys ordii	217	9.2
Thomomys townsendii (juvenile)	367	15.5
Onychomys leucogaster	1	tr.
BIRDS		
Sturnus vulgaris	5	0.2
unidentified icterid	6	0.2
unidentified medium bird	6	0.2
unidentified small bird	8	0.3
ARTHROPODS		
unidentified crayfish	1	tr.
Totals	2359	100

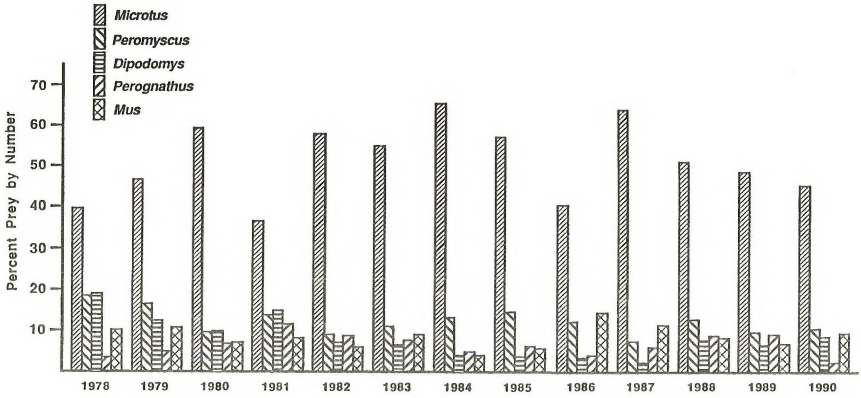

Fig. 1. Annual variation in the numeric frequency of major prey of barn owls in the SRBOPA.

Table 3. Comparison of pellet collection data from sites occupied by barn owls in the SRBOPA.

	Year of Collection											
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Number of occupied sites	15	13	25	16	16	19	15	5	4	7	2	4
Number of pellet collections	33	18	38	22	28	33	26	11	8	18	4	12
Total number of prey identified	5426	3326	5359	5074	4142	7475	5559	996	1451	3552	639	2359
Number annual collecting visits	3	3	3	2	3	3	3	2	2	3	1	3

Nest Box Use, Reproduction, Movement, Food Habits, and Annual Cycle of Body Mass of Western Screech-owls and Northern Saw-whet Owls in the Snake River Birds of Prey Area

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Annual Summary

The number of sites occupied by western screech-owls (Otus kennicottii) and the number of young hatched increased in 1990. Northern saw-whet owls (Aegolius acadicus) utilized 8 nest boxes, placed for western screech owls, in the riparian area along the Bruneau and Snake River arms of C. J. Strike Reservoir. Northern saw-whet owls have not nested in the boxes since 1987.

OBJECTIVES:

1. To determine patterns of nest box use, fidelity to site and mate, reproductive success, food habits, and the annual cycle of body mass in Western screech-owls.

2. To determine productivity, mating system, and breeding season diet of northern saw-whet owls.

METHODS

Two nest box locations were added to the study during 1990 (Table 1). All nest boxes were visited monthly from December through May and in October and November. Boxes with breeding owls were visited during May to band young. Northern saw-whet owl nests were considered successful if young were old enough to be banded. All northern saw-whet owl young were banded in boxes when they were 17 to 30 days of age.

During each visit to western screech-owl boxes (excluding incubation and early brood rearing) all cast material was collected, prey remains were noted, all unbanded birds were banded, and the body mass of adult size owls was determined using a Pesola 300-g spring scale. The sex of western screech-owls was determined during the breeding season by the presence or absence of a incubation/brood patch. Western screech-owls encountered between October and April could be separated as less than or greater than one year of age based on the underwing color. Screech-owl nest boxes were not visited often enough to determine the number of eggs laid or hatched or the number of young fledged.

Female northern saw-whet owls were captured in nest boxes during incubation. Male saw-whet owls were captured in a mist net placed in front of the nest box entrance during incubation and brood rearing. Adults were banded and weighed at the time of capture. All pellets and pellet fragments

found in northern saw-whet owl nest boxes were collected after the young fledged. Whole small mammals were identified at one site where the female died during incubation.

RESULTS

Western screech-owls were found at 21 of the 33 available sites (Table 1). Eight sites were occupied by northern saw-whet owls, and 3 were occupied by American kestrels (*Falco sparverius*).

Western Screech-owls

Eggs were laid at 9 of the 21 sites occupied by western screech-owls. Seven of the 9 breeding sites contained young owls at banding. Two sites failed during incubation. Predation was the suspected cause of failure at both sites.

Fifty-five screech owls were banded in the study area during the 1990 field season. Thirty-seven nestlings, 17 owls of less than 1 year of age, and 1 owl older than 1 year of age were banded. There have been 226 screech owls (134 nestlings and 92 adult size owls) banded in the study since 1980.

We obtained 65 body mass measurements from adult-sized western screech-owls (31 female, 11 male, and 23 from owls of unknown sex). Female owl weights range from 194-267 g. Male owl weights ranged from 160-215 g. Weights of owls of unknown sex ranged from 161-230 g.

Northern Saw-whet Owls

Northern saw-whet owl sites were located when an owl was seen peering from the box opening or was in the box when it was opened. Northern saw-whet owls used 8 of 33 sites available within our study area. The saw-whet owls were only seen in nest boxes during the courtship and breeding season. All of the sites occupied by saw-whet owls were in the riparian areas adjacent to C. J. Strike reservoir. Four of the sites were in willow *(Salix spp.)* groves, 3 were in dense Russian olive *(Elaeagnus angustifolia)* groves, and 1 was in a single Russian olive tree with a scattering of willows nearby. Two of the sites, Bruneau Marsh South and Treeline II, were used by northern saw-whet owls in 1987. The Crane Falls Lake site utilized by saw-whet owls in 1987 was not available for use in 1990.

We obtained clutch size at 5 northern saw-whet owl sites (Table 2). One female laid 5 eggs, 2 females laid 6 eggs, and 2 females laid 7 eggs (mean=6.20, s.d.= 0.75). All of the eggs hatched. At banding one nest contained 4 young, one nest contained 5 young, 2 nests contained 6 young and, 2 nests contained 7 young (mean=5.83, s.d.=1.07).

The nest failure at Dunes Entrance Pond appears to have been caused by the death of the female. She was found dead in the nest box with 4 whole and 2 broken eggs. The cause of her death was not determined. There were 11 small mammal carcasses in the box. The desertion of the Loverridge Bridge box appears to have been caused by the death of one of the adults (probably the male) prior to egg laying. A saw-whet owl carcass was found on the ground while a second saw-whet owl was peering from the nest box (Colleen Sweeney pers. commun.).

Eleven adult and 35 nestling northern saw-whet owls were banded at the nest boxes during the 1990 season. All adults at the successful breeding sites were captured for banding except the male at Treeline II. None of the adult owls captured during 1990 were owls banded during 1987. All of the adult owls were weighed during banding except the female at the Three Forks site. The body mass at first capture ranged from 75-81 g for males (mean=77.60, s.d.=2.50, n=5) The females' body mass at first capture ranged from 126-136 g (mean=131.20,

Table 1. Location and status of roosting/nesting boxes available to owls in the Snake River Birds of Prey Area, 1990.

Location Name	Status[1]	Nesting Success
BPNA East Boundary	WSO roosting[2]	
Black Butte, Lower Lower	WSO roosting	
Black Sands III	WSO roosting	
Bruneau Boat Launch	vacant	
Bruneau Marsh	WSO breeding	unknown success
Bruneau Marsh North	NSO breeding	successful
Bruneau Marsh South	NSO breeding	successful
Bruneau Marsh West	vacant	
Bruneau Rest Stop	vacant	
Cabin Draw	WSO breeding	unknown success
	AK breeding	unknown success
Castle Creek Mouth North IV	WSO breeding	unknown success
Cellar Hole	WSO breeding	unknown success
Crane Falls Sturgeon	vacant	
Delta East	WSO roosting	
Delta South	WSO breeding	unsuccessful
Delta West	NSO breeding	successful
Dunes Entrance Pond	NSO breeding	unsuccessful
Flat Iron Marsh	vacant	
Harris	WSO breeding	unsuccessful
	AK breeding	unknown success
Jacks Creek	WSO breeding	unknown success
Little Valley School	WSO roosting	
Loverridge Bridge	NSO roosting	
	WSO roosting	
Orcutt Treeline	NSO breeding	successful
Rabbit Springs	WSO breeding	unknown success
River Road	WSO breeding	unknown success
	AK breeding	
Strike Camp	WSO roosting	
Strike Dam	WSO roosting	
Strike Ditch	vacant[2]	
Strike Reservoir	WSO breeding	unknown success
Strike Camp Treeline II	WSO roosting	
	NSO breeding	successful
Three Forks	WSO roosting	
	NSO breeding	successful
Tom Draw	WSO roosting	
Two Forks	vacant	

1 AK = American kestrels; WSO = Western screech-owl; NSO = Northern saw-whet owl.
2 New nest sites available in 1990.

Table 2. Status, productivity, and adult weights of northern saw-whet owls in nest boxes in the Snake River Birds of Prey Area, 1990.

Site Name	Status[1]	Number of eggs	Number of young	Weight (g) of males	Weight (g) of females
Bruneau Marsh North	successful	5	4	75	129
Bruneau Marsh South	successful	5	5	77	135
Delta West	successful	6	6	80	126
Dunes Entrance Pond	unsuccessful	6	0	---	---
Loverridge Bridge	occupied	0	0	---	---
Orcutt Treeline	successful	7	7	81	136
Three Forks	successful	unk	6	75	---
Strike Camp Treeline II	successful	7[2]	7	---	130

1 A nest was considered successful if young were banded.
2 Clutch size was ascertained during hatching.

s.d.=3.76, n=5). The female at Bruneau Marsh South lost 30 g over a 28-day period during incubation and brood rearing.

No prey remains were found at one site that was occupied in February but not used as a breeding site.

DISCUSSION

Northern saw-whet owl breeding in the study area appears to depend on the availability of small mammals. As in 1987 the sightings and signs of small mammals were more common in 1990 than in 1988 and 1989. Although sightings and signs of montane voles *(Microtus montanus)* were not as common as in 1987, we heard many small mammals moving through the vegetation while waiting for the owls to enter the mist nets. The small mammal population was so high in one corn field at the C. J. Strike Wildlife Management Area that rodent movements through the field made it sound like a wind was moving over the field. During February, 1988, the saw-whet owls were the most vocal of the 5 species of owls near the headquarters buildings of the C. J. Strike wildlife management area (Elroy Taylor pers. commun). No saw-whet owls nested in the boxes during 1988.

ACKNOWLEDGMENTS

We thank Dick Orcutt, Manager of the C. J. Strike Wildlife Management Area, for his support and interest in this study.

Post-Nesting Ecology of the Long-Eared Owl (*Asio otus*) in Southwestern Idaho

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Annual Summary

A thesis was completed in May 1990, in partial fulfillment of the requirements for a Master of Science degree at Boise State University. An abstract of the thesis is presented here.

OBJECTIVES:

1. To determine the timing, distances, and directions of movements of long-eared owls when they leave their nest groves.
2. To compare prey deliveries by male and female parents during the post-fledging period.
3. To determine whether adult and juvenile hunters select different prey.

ABSTRACT

To study the post-nesting activities of the long-eared owl (*Asio otus*) in the Snake River Birds of Prey Area, Idaho, I radio-tagged 8 adult males, 6 adult females, and 12 juveniles at 8 nests in 1988 and 1989. I used 10-g transmitter packages (Biotrack, Wareham, Dorset, England) attached with a backpack harness. I studied behavior during the fledgling period, movements after the owls left their nest groves, and their food habits.

Young long-eared owls left the nest at about 3 weeks of age, began to fly at 4.5-5 weeks, and became independent of their parents at about 10-11 weeks of age. Before they could fly, owlets roosted singly and high in trees; after they could fly, owlets roosted in groups more often and lower in trees. These patterns may be predator-avoidance mechanisms. The oldest owlets in a brood began to make long adult-style hunting flights for 1-2 weeks before independence, whereas their younger siblings made only short flights <10 min in duration.

Adult females were more protective of the young, whereas adult males delivered 2.5 times more prey than females. Females deserted when the young were about 6.5-8 weeks of age and could fly well enough to escape most predators on their own. The males stayed behind and continued to provide food. The cost of desertion (losing her brood) for the female at this stage should be slight, because her role of protection is over.

In 1988, the owls left the BOPA abruptly, and I did not find any of them during 13 000 km of searches by truck and 18 hrs of aerial searches, covering a 90-150 km radius from

the nest sites. In 1989, I found 7 of 13 radio-tagged owls after they left the BOPA, 3 adult females, 2 adult males, and 2 juveniles. All went north into the mountains, 72-125 km from the nest groves. Four of these owls eventually moved into forested habitat after first using more open areas. Three moved to within 2 km of active logging, and one moved near year-old logging, perhaps to take advantage of displaced rodents.

I identified 4638 prey from pellets of long-eared owls collected between March 1988 and December 1989. Over 99% were 11 genera of small mammals, and 0.8% were birds. The most numerous prey were *Peromyscus maniculatus* (36%), *Perognathus parvus* (23%), *Dipodomys ordii* (23%), *Microtus montanus* (7%), neonate *Thomomys townsendii* (5%), and *Reithrodontomys megalotis* (3%). The most important contributors to the biomass were *Dipodomys* (38%), *Peromyscus* (21%), *Thomomys* (15%), *Perognathus* (12%), *Microtus* (7%), and neonate leporids (2.5%).

The proportions of the prey taxa in the diet varied over the seasons. *Peromyscus* and *Dipodomys* were highest in the winter and spring, *Microtus* in the spring, and *Perognathus* in the summer. The increase in *Perognathus* from spring to summer was gradual and began before owlets fledged in mid-May. The diets of hunting juvenile owls did not differ from those of adults at the same place. One adult owl which remained in the BOPA until September consumed over 80% *Perognathus*. These data indicate that the increase in proportions of *Perognathus* in the summer diet of long-eared owls is not owing to prey choice by juvenile owls but rather is a result of changes in the population numbers or availability of this rodent. Seasonal changes in the availability of prey species may be part of the reason long-eared owls leave the desert in the summer.

Home Range, Activity Budgets, and Habitat Use of Ferruginous Hawks (*Buteo Regalis*) Breeding in Southwest Idaho

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Annual Summary

A thesis was completed in December 1990, in partial fulfillment of the requirements for a Master of Science degree at Boise State University. An abstract of the thesis is presented here.

OBJECTIVES:

1. To determine habitat use, home range size, and core areas of use of nesting male ferruginous hawks.

3. To assess the relationship between wildfires and home range size, habitat use, and productivity.

ABSTRACT

I estimated home range size and habitat use of 7 radio-equipped male ferruginous hawks (*Buteo regalis)* nesting in southwestern Idaho during 1988 and 1989. Based on minimum convex polygons, home range sizes averaged 7.6 km^2. Home ranges consisted of a variety of habitat types, and habitat use within home ranges differed significantly from that which was available. A slight trend toward use of open habitats was noted, but the amount of grass and rehabilitated burned area within home range did not appear to affect home size or nest productivity.

Red-tailed Hawk Predation on Snakes: The Effects of Weather and Snake Activity

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Annual Summary

Snakes are important prey for red-tailed hawks (Buteo jamaicensis). In 1990, I examined the dynamics of red-tailed hawk predation on snakes during this raptors' nesting period on the Snake River Birds of Prey Area in southwestern Idaho. I measured the rate of hawk predation on snakes through direct observation of prey deliveries to 2 red-tailed hawk nests from 8 May to 21 June. I experimented with time-lapse photography of prey deliveries to determine if this method of observation would be viable. Body temperature and activity patterns of 5 gopher snakes (Pituophis melanoleucus) implanted with activity and temperature-sensitive radiotransmitters were recorded from 25 April to 26 June with telemetry equipment. A weather station collected meteorological data from 15 April to 26 June for analysis of the effects of weather on snake activity and red-tailed hawk predation.

One hundred eighty-nine hrs of red-tailed hawk nest observations were made. Observed prey deliveries show that snakes made up 42% (30 of 72) of observed prey items delivered to the nest or eaten away from the nest by the adult hawks. These 30 snakes made up approximately 65% of the hawks' total observed diet biomass. Gopher snake activity and body temperature were recorded for 1785 hrs from 25 April to 26 June.

During the 1991 red-tailed hawk nesting season, data will be collected using methods previously described. I will then analyze the 1990 and 1991 data to determine: 1) How weather conditions and snake activity affect red-tailed hawk predation on snakes, and 2) How weather conditions affect species of prey and their times of delivery to the nest, and how this varies throughout the day and season.

OBJECTIVES

1. Examine how weather conditions and snake activity affect red-tailed hawk predation on snakes.
2. Examine how species of prey and the times of delivery to the nest vary throughout the day and nesting season.

METHODS

My study area was on the eastern side of the Snake River Birds of Prey Area (SRBOPA), near Hammett, Idaho. Weekend surveying trips to this area began in late March and early April. Chalk Gulch, Pump Draw, Pump I, Pump II, and Hammett red-tailed hawk territories were located west of Hammett. From these territories, my study area was defined. The Hammett

nest was later eliminated from the study due to the difficulty of making accurate observations of prey deliveries.

I recorded a "prey delivery" whenever an adult bird brought fresh prey to the nest or to the area immediately near the nest. Species of prey and time of day were recorded for each prey delivery. I observed Chalk Gulch and Pump Draw nests from a vehicle during the 1990 nesting period. Observations were made at distances of approximately 60 and 100 m respectively, with a Nikon 40 power spotting scope. Each nest was observed on alternating days. Observation times were from 0700 hrs to 1400 hrs, or from 1400 hrs to 2100 hrs. When observing a specific nest, the observation time would alternate from the morning period on one observation day to the evening period on its next. Thus, after 4 observation days, both nests were watched over all of the daylight hrs. Before each series of 4 observation days, the nest observed first was randomly chosen and watched in the morning, the second nest in the evening on the following day.

When recording prey returns from the nest blind, prey items were categorized as small, medium, or large within its particular species. Biomass estimates of each prey item was then determined from Steenhof (1983) and C. R. Peterson (pers. commun.).

Attempts were also made to test the viability of making observations with time-lapse cameras on Pump I and Pump II nests. These nests turned out to be unsuitable for the cameras. On 2 June, a Minolta XL 104 super 8 mm movie camera, set for 60 sec time-lapse photography, loaded with Kodachrome 40 film was placed approximately 4 to 5 m above and to the side of Pump Draw nest. The camera was held 1.2 m away from the cliff face by an arm made of 5 x 5 cm (2 x 2 inch) boards. A white 20-cm diam dial-type clock was epoxied to the rock face about 1 m above the nest. Installation took about 1.3 hrs. This camera was in place from 1150 hrs to 2115 hrs.

Gopher snakes were hand captured by searching the canyon rim and the riparian zone. Captured snakes were brought to Idaho State University (ISU) where they received surgically implanted Telonics CHP radiotransmitters (150 to 152 MHZ) equipped with temperature and motion sensors. Gopher snakes were used because they are a major prey item (Steenhof and Kochert 1985), abundant, and large enough for transmitter implants.

Gopher snake activity and body temperature was recorded with a mobile single channel receiving station consisting of a receiver, cassette recorder, timer, 12-volt battery, and a multichannel radiotelemetry receiving base station, which included a receiver, signal processor, and cassette tape recorder. From 25 April to 11 June, the mobile station was moved randomly to monitor one of the snakes per day. From 11 June to 26 June, snake activity and body temperature was sampled at 5-min intervals, 24 hrs per day by the base station. All radiotransmitter signals were stored on cassette tape in the field and down loaded onto a microcomputer at ISU for analysis.

Weather data included measurements of short wave radiation, wind speed, and air, soil, and snake model temperatures. Mean values were recorded at 15-min intervals with a Campbell Scientific CR10 micro datalogger. Short wave radiation was measured with a Li-Cor pyranometer. Wind speed was measured with a Weathertronics cup anemometer 2 m above the ground. All temperature measurements were made with thermocouples. Shaded air temperatures were measured at 1 and 200 cm above the ground. Soil temperatures were taken at the surface and at depths of 2 and 20 cm. Operative snake (model) temperatures were measured with appropriately painted, 30.5 cm x 2.5 cm copper tubing (Peterson 1987)

placed on rock and dirt locations that were exposed to sunlight. Precipitation was measured with a plastic All Weather rain gauge.

RESULTS AND DISCUSSION

Chalk Gulch and Pump Draw red-tailed hawk nests were observed for 189 hrs (Table 1). Forty-two percent (30 of 72) of the prey deliveries to the nest or prey eaten away from the nest by the adult red-tailed hawks were snakes (Fig. 1). Prey items included 15 gopher snakes, 7 racers (*Coluber constrictor*), and 8 unidentified snakes. These snakes made up approximately 65% of the observed diet biomass of the red-tailed hawks (Fig. 2). No western rattlesnakes (*Crotalus viridis*) or garter snakes (*Thamnophis elegans*) were observed prey items, although they were seen in the study area.

On 5 May while preparing to install the time-lapse camera on the Pump I nest, it was discovered that the nest had been abandoned sometime after 27 April. Speculation the reasons for its abandonment include; 1) inexperienced adult pair of birds, 2) competition for prey with nearby nesting golden eagles (*Aquila chrysaetos*), great horned owls (*Bubo virginianus*), prairie falcons (*Falco mexicanus*), common ravens (*Corvus corax*), and another pair of red-tailed hawks, 3) exposure of this nest to direct sunlight throughout most of the daylight hrs, and 4) human disturbance. I was working with snake telemetry equipment for approximately 30 min per day at a distance of about 200 m from the nest and I may have inadvertently disturbed them. The nest contained 4 eggs. The arrangement of the rock surrounding the Pump II nest did not allow for an adequate view. Thus, observations of Pump I and Pump II nests could not be made with the time-lapse camera.

A time-lapse camera was mounted near Chalk Gulch nest on 2 June. The behavior of the hawks was watch until 2100 hrs. Many close "fly-bys" were made by both adults. Only the female perched on the nest at about 1800 hrs with a Townsend's ground squirrel (*Spermophilus townsendii*). She stayed on the nest for only 60 sec. The prey was not fed to the 2 nestlings (then approximately 10 days old). Because of this disturbed behavior, I took the camera and mount away from the nest at 2115 hrs that evening. The female was on the nest when I checked at dawn the next morning.

Table 1. Red-tailed hawk nest observation periods at the Snake River Birds of Prey Area, near Hammett, Idaho, 1990.

Nest	First Date Observed	Last Date Observed	Days Observed
Chalk Gulch	8 May 1990	13 Jun 1990	14
Pump Draw	15 May 1990	21 Jun 1990	13

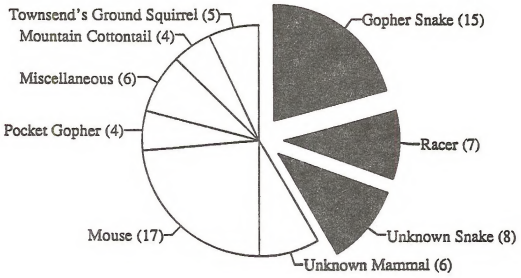

Fig. 1. Observed prey of Chalk Gulch and Pump Draw red-tailed hawks delivered to (or eaten away from) the nest on the Snake River Birds of Prey Area, 1990.

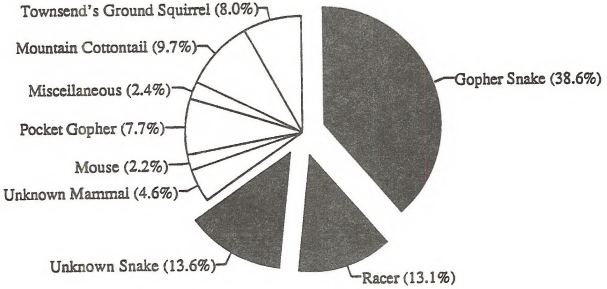

Fig. 2. Observed prey biomass of Chalk Gulch and Pump Draw red-tailed hawks delivered to (or eaten away from) the nest on the Snake River Birds of Prey Area, 1990.

Body temperatures and activity patterns of 5 gopher snakes captured and released on the north side of the river were monitored by both telemetry stations for a total of 1,785 hrs (Table 2). One transmitter was used on 2 different snakes. This transmitter was removed from the first snake when it was discovered that the sutures failed to hold after the snake had been released in the field. The transmitter was later implanted in another snake. The first snake's sutures were repaired before it was released again, without a transmitter.

The mobile telemetry station worked exceptionally well. Its only drawback was the delay at the beginning of each 10-sec recording interval to achieve a processable signal when the system was cold at night and in the early morning. Even so, 30 nocturnal recordings were made.

From 11 June to 26 June the base telemetry station was set up on the canyon rim, across the river (south side) from the implanted snakes. Processable signals were picked up from 3 snakes up to 1 km away. This station could record data from snakes over a range of at least 2 km of the river canyon.

Three patterns of activity can be seen from preliminary analysis of the data. When environmental temperatures are low, snakes typically stay underground, presumably to avoid the cold (Fig. 3). When these temperatures begin to rise in the spring, snakes become active and tend to emerge from their burrows in the late morning and retreat back in the late afternoon-early evening (Fig. 4). As temperatures continue to increase during the summer, a bimodal pattern of activity becomes evident (Fig. 5). In this case, the snakes retreat to the shade or back to the burrow during the hottest part of the day. These activity patterns coincide with those observed by Lowell E. Diller and Charles R. Peterson (pers. commun).

Snake #7002 was probably captured and eaten by the Pump II red-tailed hawks between 0907 hrs on 31 May and 0900 hrs on 3 June. I found the transmitter below the nest at 0900 hrs on 3 June, with a kink in its antenna, but it was still working. At this time only the mobile telemetry station was in the field, and unfortunately it was recording another snake between 31 May and 3 June. It would have been ideal if data from this snake were being recorded at its

Table 2. Activity and body temperature monitoring periods of 5 gopher snakes at the Snake River Birds of Prey Area, near Hammett, Idaho, 1990.

Snake	First Date Monitored	Last Date Monitored	Hrs Monitored
#3720(1)	25 April	6 May	112.7
#3720(2)	13 May	26 June	519.5
#7002	22 May	2 June	93.4
#7410	3 June	26 June	678.1
#7821	7 June	26 June	381.3
		Total	1,785.0

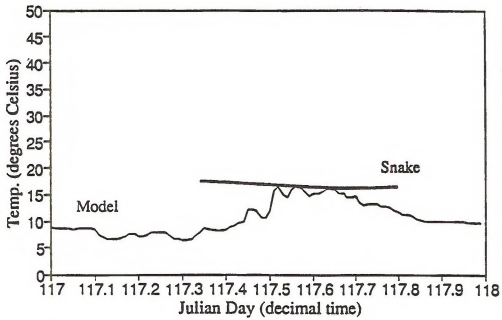

Fig. 3. Gopher snake #3720 and dirt model temperatures from the Snake River Birds of Prey Area, 27 April 1990.

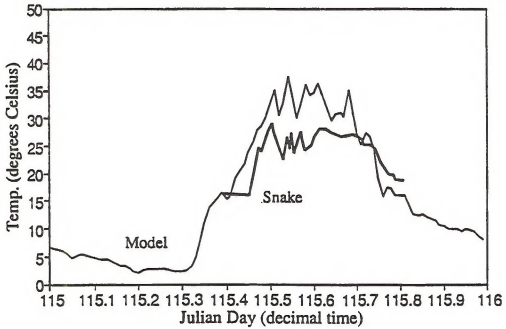

Fig. 4. Gopher snake #3720 and dirt model temperatures on the Snake River Birds of Prey Area, 25 April 1990.

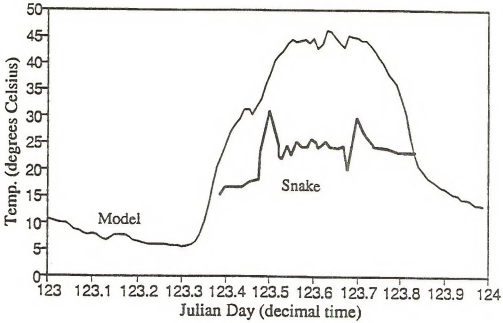

Fig. 5. Gopher snake #3720 and dirt model temperatures from the Snake River Birds of Prey Area, 3 May 1990.

time of capture, then its body temperature and activity would have been evident.

Snake #7410's signal on 26 June indicated that it had crossed to the south side of the river (its exact location was not determined). On 26 August, this snake's transmitter was found on the south side of the river, in line with the 26 June location. The transmitter was found approximately 30 m from the river, in a poison ivy (*Rhus toxifolia*) patch. Its antenna was broken off where it exits the transmitter casing. Mike Balistreri (ISU graduate student) keyed out a small clump of shrew hair that was attached to the transmitter. No part of a raptor pellet was found near the transmitter. The snake may have been killed and eaten by a coyote, dog, or badger.

In the first year of this study, as well as in studies by Fitzner et al. (1981), Stinson (1980), and Knight and Erickson (1976), snakes have been shown to be an important part of the diet of red-tailed hawks, especially in the spring when nesting hawks require increased amounts of prey. The availability of snakes as an alternate food item could be crucial to the nesting success of these raptors, particularly when Townsend's ground squirrels and other prey numbers are low. Consequently, information concerning snake activity and their thermal regulation is potentially very useful for the management of raptor populations. This is especially true with respect to relating weather to the availability of snakes as prey items.

ACKNOWLEDGMENTS

I am thankful to the following people for their contributions to my study. Dr. Charles H. Trost and Dr. Charles R. Peterson (both of ISU) provided help in obtaining and using equipment. Dr. Trost also allowed me use of his camper while in the field. Deborah

Scibior-Grothe brought me supplies and transported snakes to and from ISU. Electricity was obtained by permission from Robert Gibson, who maintains the "Flying H" pump station on the north side of the Snake River with in the study area. Access to private land was obtained by Robert Bledsoe and Dale Hooley. Dale and Diana Hooley also allowed me to use their shower and provided me with and occasional meal. Three time-lapse cameras were obtained; 2 from Dr. Richard Fitzner of the Hanford Nuclear Reservation in Washington, and 1 from Jeff Marks of the Univ. of Montana. Phil Leavitt of Gateway Cyclery, and the employees at the Yellowstone Avenue Radio Shack (both of Pocatello) assisted with equipment set up.

PLANS FOR THE 1991 FIELD SEASON

In the 1990 field season, only the time-lapse cameras did not work as planned. They will not be used in 1991, due mainly to their inability to record prey items not brought to the nest. The stationary telemetry station will be in place at the beginning of the field season. The mobile telemetry station will be kept warm during cool temperatures by a small incandescent light inside its protective box. Also, a solar panel will be used to keep batteries charged in this system as well. When traveling on roads that run along the edge of the river, data will be recorded on snakes species seen, body posture, and their direction of travel. Pending additional funding, more snakes will be captured and implanted with radiotransmitters. Two additional transmitters will be needed to replace those whose batteries may die this winter. I will then monitor snakes radio-implanted and released on both sides of the river. The weather stations' location on the rim of the canyon will be moved to a position half way down the slope to more accurately monitor the environmental conditions to which the snakes are exposed. Weather data will also be recorded at 10-min intervals (instead of 15 min) to provide a better comparison with snake activity and body temperature data. Also I would like to hire 2 field assistants to increase the number of hrs spent observing red-tailed hawk nests. The field camp will be located on the south side of the river under shade if possible.

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Parasites and Population Ecology in Kangaroo Rats

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Annual Summary

Kangaroo rats were trapped in Owyhee County, Idaho during summer 1990. Parasite loads were quantified, and effects of parasites on kangaroo rats' digestive efficiency were determined using experiments on caged animals.

OBJECTIVES:

1. To gather baseline data on the prevalence in kangaroo rats of selected parasite species.

2. To perform preliminary studies to determine the effect of selected parasite species on the energy budget of host kangaroo rats.

INTRODUCTION

Little empirical evidence exists to allow a critical assessment of the role of parasitism in host population ecology. Over the last 4 years I have initiated studies that study the effects of parasites at 2 levels: (i) on the energy budget of host individuals and (ii) on the reproduction and survival of individuals. Effects at either level should have important ramifications for host populations.

Research that I recently completed in Wisconsin documented effects of 2 parasites, a tapeworm and a fly larva, on host white-footed mice. We showed that (i) both parasites have small but measurable effects on the host energy budget, (ii)we were unable to detect compensations for these perturbations in the energy budgets, leading us to conclude that effects on energy budget were not of major significance, (iii) we were unable to detect effects of either parasite on survival or reproduction (Munger and Karasov 1989 and in press, Munger et al. 1989).

The goal of the present research is to gather similar evidence on a different system. It is hoped that the methods I am using will eventually provide a means by which probable effects on host population dynamics can be predicted by study of parasites on selected components on the host energy budget.

METHODS

My study site consists of a 13 x 13 grid with 15 m between stations, which was established in Rabbit Creek, Owyhee County, on the plain approximately 500 m west of Con Shea road, at T2S R2W S14.

Two trapping sessions were conducted during Summer 1990, 14-22 June and 15-18 August. Fecal specimens from captured kangaroo rats were analyzed for the presence of parasite eggs by standard centrifugal flotation techniques using saturated sucrose solution (Pritchard and Kruse 1982). Animals captured were subjected to the following experimental design. Animals were placed in wire-bottomed cages for a 5-day period with a measured amount of millet seed. Fecal pellets were collected, and dry matter digestibility (DMD) will be calculated by the formula (Food consumed - Feces produced)/(Food consumed). After this trial half of the animals from each species were injected with ivermectin, a drug that kills nematodes. The other half received a control solution. The animals were then subjected to another DMD trial.

RESULTS

Two species of rodent at my site, *Dipodomys ordii* and *Dipodomys microps*, are infected with whipworms (*Trichurus* sp., a nematode). Interestingly, *Trichurus* occurs at substantially higher prevalence in *D. microps* (Table 1). Samples from the 2 experiments are presently being analyzed, so no data is available from those experiments.

PLANS FOR 1991

I will first complete analysis of data resulting from the experiments of summer 1990. I plan to carry out at least 1 more DMD experiment. I will also investigate (i) the possibility of artificially infecting Kangaroo rats with *Trichurus*, and (ii) the reason that the 2 species differ in their rates of infection with *Trichurus*.

Table 1. Infection of 2 species of Kangaroo Rat with the nematode *Trichurus* sp.

	D. microps		*D. ordii*	
	Infected	Uninfected	Infected	Uninfected
June trapping	10	5	5	39
August trapping	6	9	7	34

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1990 Monitoring Studies on Greenstrip Projects in the Snake River Birds of Prey Area

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Annual Summary

Monitoring of greenstrip projects is continuing with data collection at 23 study sites on 7 greenstrip projects. In addition, 12 new study sites were established on 3 greenstrip projects during the 1990 field season. Evaluation reports on all greenstrip projects are being prepared at this time.

OBJECTIVE

To monitor establishment and persistence of plants used to establish strips of fire resistant vegetation (i.e., greenstrips) in the Snake River Birds of Prey Area (SRBOPA).

METHODS

Two similar study procedures are used to determine if objectives are being met. Most greenstrip projects are monitored with a procedure that combines cover, density, phenology and frequency data collection. This procedure, called "Freqdens", is described in a previously published report (Pellant 1989).

Prior to the initiation of the "Freqdens" procedure in 1989, selected greenstrip projects were monitored using a pace transect. The same vegetation sampling procedures are utilized with the pace transect and "Freqdens" techniques. The primary difference is the use of 5 short belt transects with "Freqdens" versus the use of 1 long pace transect in the pace transect technique. Closeup and general view photographs are taken on all studies. Handbooks describing step by step procedures to establish and re-read both "Freqdens" and pace transects are being prepared.

RESULTS AND DISCUSSION

During the 1990 field season, 23 study sites on 7 greenstrip projects were visited and monitoring studies re-read. Two new study sites were established on the Crater II greenstrip northwest of Crater Rings. The new Crater Rings study sites will monitor vegetation on that portion of the greenstrip reseeded in 1989. The original greenstrip seeding was determined to have failed as a result of a multiple year drought.

Eight new studies sites were established on the Swan Falls Road greenstrip in the western portion of the SRBOPA. This greenstrip was seeded in the fall of 1989. Annual grassland and big sagebrush (*Artemisia tridentata*) sites adjacent to the greenstrip were also monitored to compare seeding treatments with untreated rangeland.

Two new study sites were established on an experimental greenstrip near Simco Road. A new site preparation and seeding machine (disk chain) was used to seed a crested wheatgrass (*Agropyron cristatum*) and forage kochia (*Kochia prostrata*) mixture in 1986. Forage kochia is an introduced half-shrub that is very competitive with cheatgrass (*Bromus tectorum*) and retains fire resistance throughout the summer. These studies will document the competitive interactions between forage kochia and native species along 4 160-m transects. The transects originate at the greenstrip boundary and run into adjacent rangeland.

Density measurements show that shadscale (*Atriplex confertifolia*), the dominant prefire shrub, and forage kochia are increasing on this study site. Density of forage kochia (4,582 plants per ha) is greater than shadscale (1,976 plants per ha). The greatest numbers of forage kochia plants are near the greenstrip which provides the seed source for recruitment.

Detailed evaluation reports for each greenstrip project in the SRBOPA are being prepared. These reports will include site preparation and seeding descriptions, management actions, climatic information and monitoring data and are expected to be completed by April 1990. Monitoring of selected greenstrip projects in SRBOPA will continue in 1991.

ACKNOWLEDGMENTS

S. Riley and L. Eno collected and compiled monitoring data and are preparing project evaluation reports.

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Environmental Monitoring in the Idaho Army National Guard Orchard Training Area

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Annual Summary

Two hundred seven permanent land condition-trend vegetation/soil monitoring (LCTA) plots established in 1989 were monitored, and small mammals were inventoried on selected LCTA plots. Eight new special-use LCTA plots were established in the OTA on native-shrub transplant sites. In addition, 49 LCTA control plots were established on BLM land within 3.2 km of the Orchard Training Area boundary; 2 of these were special-use plots. Monitoring began on a candidate 2 plant species, Lepidium papilliferum. Several plant species not previously collected in the training area were identified and archived in herbaria.

OBJECTIVE

To assess and monitor the land condition and mammal populations in the Orchard Training Area in order to minimize the impacts of National Guard training.

METHODS

Vegetation/Soils Monitoring

A May 1989 SPOT satellite image of the Orchard Training Area (OTA) was obtained, and it was digitized using GRASS (Geographic Resources Analysis Support System), a computerized geographic information system. Forty-nine control plot locations were selected with GRASS, using the method of Warren et al. (1990). When establishing the control plots in the field, no effort was made to avoid trails, tracks, or other disturbances. Two of the preselected control plot locations were impractical for sampling, occurring on Snake River Canyon cliff-faces. Therefore, no plots were established at these 2 locations. Instead, 2 special-use (locations selected by the field crew leader) control plots were established, 1 inside the 1980 grass grazing exclosure, and 1 inside the 1980 winterfat grazing exclosure.

In addition, 8 new special-use LCTA plots were established inside the OTA, to monitor native shrub-seedling mortality/survival on 1990 shrub transplant sites. These special-use plots included 3 sites in the impact area south of the drift fence, 2 impact area sites north of the drift fence, 1 site east of Range 6 and north of Cinder Cone Butte, a site on Big Foot Butte, and a site on the north slope of Christmas Mountain.

When a plot location was reached, a plot-midline azimuth was selected from a random number table, and a sighting compass was used to establish the plot

midline on this azimuth. Each plot was given an identifying number.

Each LCTA plot consisted of a rectangle 6-m wide and 100-m long, extending 3 m on either side of the plot midline. At every new plot location, the midline was laid out using a 100-m tape. Each midline was permanently marked with steel stakes. At 0 m on the midline, a 1.27-cm pipe (i.d.) 46 cm long was driven into the ground, and a steel stake 0.63 cm in diameter and 46 cm long was dropped into it. At 25 m, 50 m, 75 m and 100 m on the tape, another 46-cm steel stake was driven into the ground. On plots established in 1989, the in-place stakes were located and the 100-m tape attached to them while the transect was being monitored. In the 1990 monitoring of plots established in 1989, ground-aerial vegetation transects were sampled, and land use and disturbances were recorded.

Along the midline tape, a ground-aerial vegetation transect was sampled by dropping a 1-m steel rod marked in decimeters, to the ground at 1-m intervals. The type of ground cover (or lack thereof) encountered by the pin at each drop-point (ordnance, bare ground, gravel, rock, lichen, moss, grass litter, forb litter, shrub litter, dead wood, fecal material, plant species) was recorded; if the pin came to rest in a vehicle or mammal track or trail, or a mammal mound or burrow, this was recorded as well. At each sampling point, above-ground hits of litter, living plants, and dead wood on the steel rod were recorded, along with hit-height in decimeters. Litter was identified as grass, forb, or shrub litter. Living plants were identified to species and recorded by genus-species acronym.

On LCTA plots established in 1989, belt transects were not sampled in 1990. On control plots, belt transects were sampled if one or more shrubs taller than 0.1 decimeter were encountered on the plot. Shrubs were identified to species, and the location of each shrub in the belt was recorded (for example, 26 m, 1.2 m left), as well as its height in decimeters (or, in the case of transplant plots, in tenths of decimeters). Dead shrubs (snags) were recorded only if their height was equal to or greater than 1 m. However, the presence of shorter snags on a plot was noted. If the total number of shrubs of a species was fewer than 100 in the 6 x 100-m belt, a 6-m wide belt was sampled for that species. If the total number of shrubs in a 6-m wide belt was greater than 100 but fewer than 200, a 4-m belt was sampled for that species, and if there were 200-400 shrubs per 6 x 100-m belt, a belt 2 m wide was sampled. If there were more than 400 shrubs of a species present in a 100 x 6-m belt, a 1-m belt was sampled for that species. Plots having different numbers of several shrub species thus had several belt transects of different widths. Belt transects were always of equal width on each side of the 100-m midline. Belt width and shrub locations were measured using a collapsible, calibrated 6-m range pole, and shrub heights were measured using a calibrated steel rod. Belt transects were established on all 8 special-use transplant plots; on these plots, all live shrubs, regardless of height, were recorded (i.e., the minimum-height requirement of the LCTA method was waived). On the 8 special-use shrub transplant sites, every live shrub seedling that could be found was marked with a wire stake flag; the shrub seedlings were counted as the flags were removed.

Plant species not previously recorded from the OTA were collected, pressed, and identified. Evidence of livestock use, troop bivouacing, vehicle tracking, fire, or other disturbance occurring on the plot was noted. Color photographs were taken of the view down the midline of each plot and of approaches to each plot, using a 35-mm camera.

On each control and new special-use plot, at 25 m and 75 m, 1 m to the right of the midline

tape (facing the 100-m rod), 0.95 l (1-quart) soil samples were collected. The soil samples were sent to the Soil Conservation Service National Soils Laboratory in Lincoln, Nebraska, for analysis. At 0 m, 50 m, and 100 m on the plot midline, slope length and gradient were recorded using a measuring rod and a clinometer. Soil samples were not taken and slope data not recorded for LCTA plots established in 1989.

A more detailed explanation of the LCTA methods used in the Orchard Training Area can be found in the U.S. Army Land Condition Trend Analysis (LCTA) Field Methods manual (U.S. Army Corps of Engineers 1987).

In April 1990, a federally listed category 2 candidate plant subspecies was found in sagebrush stands in the northeastern portion of the OTA. Listed as *Lepidium montanum papilliferum* (Moseley and Groves 1990), the taxon is currently in revision, and is being described as a species, *Lepidium papilliferum* (Rosentreter pers. commun). In early June, sagebrush stands in the OTA were spot-checked for the presence of this species. In the area where the most individuals were counted in the spot checks, numbers of individual plants were counted on several 1-mile walking transects. Maps plotting the locations of the walking transects, numbers of *Lepidium papilliferum* observed, and dates, were sent to Roger Rosentreter, BLM state botanist, in July 1990.

Small Mammal and Jackrabbit Monitoring

The 57 LCTA plots on which small mammals were snap trapped in 1989, were also trapped in 1990. Beginning in early May and ending in early October, 57 of these plots were trapped. On each mammal-trapping plot, starting at the 0-m rod, 50 Museum Special (Woodstream Corporation, Lititz, Pennsylvania) snap traps baited with a peanut butter-oatmeal mixture were set at 2-m intervals in a straight line 5 m to the right (facing the 100-m rod) of the LCTA plot midline. Traps were set in late afternoon and checked the following morning. Each plot was trapped for 2 consecutive nights for a total of 100 trap-nights per plot. Species, sex, age class, reproductive condition, plot number, and date of capture were recorded for each animal caught.

Abundance of black-tailed jackrabbits (*Lepus californicus*) in the OTA was monitored in 1990 using the method of Smith and Nydegger (1985).

In June and July, 45 of the 57 mammal-trapping locations plus 3 special-use plots (91, 92, and 113) and 3 control plots (224, 226, and 228) were censused for Townsend's ground squirrel (*Spermophilus townsendii*, hereafter TGS) and badger (*Taxidea taxus*) burrows. Year-active burrows of both TGS and badgers were distinguished from year-inactive burrows by the presence of one or more of the following: tracks, claw marks, freshly excavated earth, trails from the burrow entrance beaten through current-year vegetation, absence of year-old or older plant litter blocking the burrow entrances, feces, exposed flexible rootlets in the burrow entrance, and observation of an animal using the burrow.

TGS and badger burrow censusing was done by counting every year-active and year-inactive burrow in a belt plot 5 m x 400 m. Each censusing plot began at the LCTA-plot 0-m stake and continued along the plot midline for 100 m, then on in a straight line for 300 more m. While sampling a plot, the pole technician carried a 5-m TGS censusing pole down the 400-m straight line. One or more recording technicians followed the pole technician. The recorder(s) searched the belt for burrows as the pole carrier walked slowly along the line ahead, recording all TGS burrows and badger burrows and noting whether they were active or inactive.

RESULTS

Vegetation/Soils Monitoring

In 1990, 207 LCTA plots in the Orchard Training Area established in 1989 were inventoried. One 1989 plot, plot 89, was not monitored in 1990 because it had been annihilated by multipurpose range complex construction. Forty-nine control plots were established outside the OTA within 2 miles of its borders, and 8 special-use plots were established in the OTA in native shrub transplant sites. On these 8 sites, all shrub seedlings were counted, so that survival and recruiting can be monitored. LCTA plot data collected are on file in the office of the U.S. Army Corps of Engineers Research Laboratory, Champaign, Illinois, and at the Idaho Army National Guard Department of Engineering, Gowen Field, Boise, Idaho.

A federally listed plant, *Lepidium papilliferum*, was discovered in the OTA, and walking surveys were done to provide a rough estimate of the species' numbers; approximately 7,000 living individuals of this species were counted. Information collected on this species in 1990 is on file in Boise, Idaho, at the Army National Guard Department of Engineering and with Dr. Roger Rosentreter, Idaho State Office of the Bureau of Land Management. Plant species recorded for the OTA as of May 1990 are listed in Appendix A; herbarium voucher specimens have been archived in the herbarium of Colorado State University, Fort Collins, Colorado. Analysis of OTA soil samples by the U.S. Soil Conservation Service National Soils Laboratory is still under way.

Small Mammal and Jackrabbit Monitoring

The 1990 mammal survey resulted in the capture of the following species in the Orchard Training Area: *Eutamias minimus, Dipodomys microps, Dipodomys ordii, Onychomys leucogaster, Perognathus parvus, Peromyscus maniculatus, Neotoma cinerea, Reithrodontomys megalotis*, and *Spermophilus townsendii*. A total of 1,149 mammals were captured. Mammal-capture data are on file in the office of the U.S. Army Corps of Engineers Research Laboratory, Champaign, Illinois, at the Idaho Department of Fish and Game, and at the Idaho Army National Guard Department of Engineering, Gowen Field, Boise, Idaho.

Black-tailed jackrabbit censusing was done as part of the BLM Snake River Birds of Prey Area monitoring effort, and OTA results are included in the section of this annual report that reports jackrabbit abundance in the Snake River Birds of Prey Area.

Townsend's Ground Squirrel and Badger Monitoring

Fifty-one burrow-count transects were sampled during June and July 1990. TGS and badger burrow transect data are on file in the office of the U.S. Army Corps of Engineers Research Laboratory, Champaign, Illinois, and at the Idaho Army National Guard Department of Engineering, Gowen Field, Boise, Idaho.

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Appendix A. Plant species of the Orchard Training Area, May 1990

Achillea millefolium
Agropyron desertorum
Allium acuminatum
Amsinckia tessellata
Artemisia cana
Artemisia ludoviciana
Artemisia spinescens
Artemisia tridentata
Artemisia tripartita
Atriplex confertifolia
Atriplex gardneri
Balsamorhiza hookeri
Bromus rubens
Bromus tectorum
Camissonia boothii
Camissonia contorta
Cardaria draba
Ceratoides lanata
Chaenactis douglasii
Chenopodium album
Chrysothamnus viscidiflorus
Circium arvense
Collinsia parviflora
Crepis acuminatus
Delphinium bicolor
Descurainia pinnata
Descurainia sophia
Elymus cinereus
Elymus junceus
Eriogonum ovalifolium
Erodium cicutarium
Erymopyrum triticeum
Erysimum repandum
Epilobium paniculatum
Gilia sinuata
Grayia spinosa
Gutierrezia sarothrae
Halogeton glomeratus
Helianthus annuus
Hordeum glaucum
Kochia scoparia
Lactuca serriola
Lepidium perfoliatum
Leptodactylon pungens
Lomatium dissectum
Lomatium grayi
Lomatium macrocarpum
Marrubium vulgare
Mentzelia albicaulis
Myosurus aristatus
Nothocalis troximoides
Oryzopsis hymenoides
Penstemon acuminatus
Penstemon deustus
Phlox aculeata
Poa secunda
Polygonum arviculare
Ranunculus testiculatus
Sarcobatus vermiculatus
Senecio hydrophyllus
Sisymbrium altissimum
Sisymbrium loeselii
Sitanion hystrix
Sphaeralcea munroana
Stipa thurberiana
Taeniatherium asperum
Tetradymia glabrata
Townsendia florifer
Vulpia octoflora
Zygadenus paniculatus

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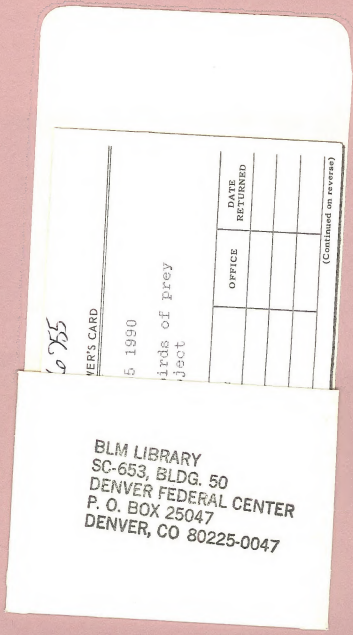
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